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NEWS AND VIEWS

We should like to draw attention to the advertisement of the COUNCIL FOR THE PROMOTION OF FIELD STUDIES elsewhere in this issue.

This organization is doing fine work and deserves the widest possible publicity. The NATURAL HISTORY COURSES are primarily for adult students. Students without specialized knowledge will be given every possible assistance in the identification of specimens but the instruction will be generally on ecological lines. There will also be demonstrations of methods of collecting and preserving plant and animal material. The FIELD COURSE IN INVERTEBRATE ZOOLOGY is intended for biologists working at undergraduate or post-graduate level, but is suitable also for teachers, specialist amateurs, museum workers and others who have already some zoological knowledge.

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A NEW BRITISH SPECIES OF AGROMYZA (DIPT. AGROMYZIDAE)

By G. C. D. GRIFFITHS

Agromyza rubiginosa sp. nov.

Head: Ratio of the width of the frons, at the level of the 1st ors, to the width of an eye, 1.7. Frons only slightly narrowing forwards, clearly longer than wide (measured to the base of the antennae). Lunule approximately semicircular, its height being about 1/4 of the distance from itself to the front ocellus; at the base of the antennae it occupies c.½ the total width of the frons. Ocellar plate reaching its point just before the 2nd ors: front ocellus set well back on it, before the 1st ors, forming an angle of c.70 deg. with the other 2 ocelli. Base of the ocellar triangle occupying c.⅜ of the width of the frons. 2 strong ors, the 2nd very slightly longer than the 1st, though not overreaching it: directed backwards. 2 strong ori, directed inwards and upwards: the 1st as long as the 2nd ors, the 2nd a little shorter. All or the same distance from the eye-margin. 2nd ors well before the middle of the frons. The 2 ori and the 2nd ors equidistant from each other, but the distance between the 1st and 2nd ors greater, and that between the 1st ors and the vti greater still. Orbital setae weak, 1-rowed, directed posteriorly. They start at the 1st ors and continue to the antennae; c.8 in all. Cheeks and orbits clearly visible in profile, evenly encircling the eye. Jowls 1/4 of the height of an eye at their middle, 1/3 posteriorly. Median keel of face flattened towards the mouth-margin, continuing between the bases of the antennae. Cheeks in front view about as broad as the diameter of the 1st antennal segment. Eyes bare. Antennae clearly separated at their base by the continuation of the median keel of the face: they are opposite the middle of the eye and fairly small. 3rd segment about as broad as long, slightly concave on its upper surface, with pubescence at its tip. Arista thickened basally, with short pubescence. Vibrissae weak; c.6 pairs of peristomal bristles.

Thorax: 3+1 strong dc, the 4th well before the suture, the 3rd behind it. c.7 rows of acr, reaching to just past the 2nd dc. c.12 ia before the suture and c.12 after. 2 pa, mspl with 8 bristles.

Abdomen: ♀. Moderately long hairs in about 3 rows on each segment. 6th tergite c.½ as long as the 5th. Basal cone of ovipositor longer than 6th segment.

Legs: T_2 without conspicuous posterodorsal bristles.

Wing: 2nd costal segment 4 times as long as the 3rd, 5 times as long as the 4th. R_{2+3} curved, r_{4+5} slightly so, ± parallel to m_{1+2}. Ta clearly before the middle of the Cd, but beyond the third. Penultimate segment of m_{4+5} a little longer than the last.

Length: Body and wing, 2.25 mm.

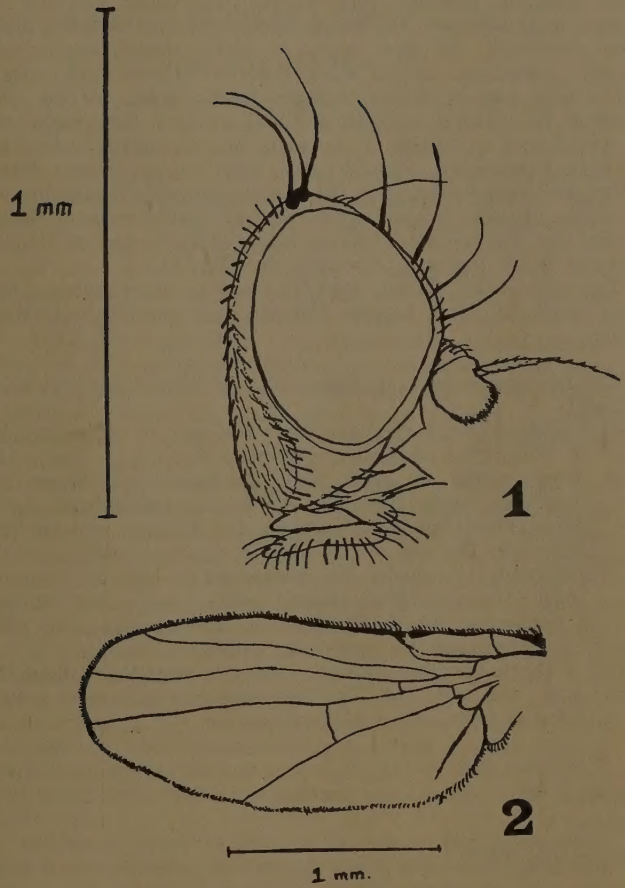


Fig. 1, Head, lateral view. Fig. 2, Wing.
Agromyza rubiginosa sp. nov.

Colour: Frons orange; ocellar plate, orbits and occiput pruinose black. Vti on black ground. Lunule orange, but face below the antennae blackish. Jowls rusty brown, with black margins. Cheeks black, pruinose. Labellum rusty brown, palpi black. Antennae: 1st segment pale brownish, 2nd darker, especially above, becoming slightly paler anteriorly; 3rd dark brown to black, though slightly paler basally: pubescence on 3rd segment whitish. Thorax and scutellum black, with grey pruinosity laterally, more shining dorsally. Mspl narrowly rusty-brown on upper and hind margins. Very slight traces of rusty-brown at the side of the suture and the humeral callus. Base of wing rusty-brown. Squama pale, with blackish fringe. Haltere white, on a rusty-brown stalk. Wing veins brownish basally, but soon becoming pruinose black. Legs black, very faintly paler at the tips of the front femora only. Abdomen black, with very narrow pale hind margins to the segments, especially the 6th (♀).

Type ♀. Chailey, Sussex. 30/5/54 (swept). Taken during a field-meeting of the South London Entomological and Natural History Society.

The new species may be distinguished in Hendel's (1939) key as follows:

31a. Stirne rotgelb, Fühler gesättigter rot, etc. ..... freyi Hd.
— 3. Fühlerglied mindestens schwarzlichrot ..... 31aa.
31aa. Stirne rotgelb. Im Profil bilden die Wangen und Stirne einen deutlichen breiten Ring über den Augen. **rubiginosa** sp. nov.
— Stirne mindestens schwarzlichrot. Die Wangen sind im Profil nicht oder nur sehr schmal vor den Augen sichtbar ..... 31b.

The alternative in couplet 28a, 'r-m ungefähr über der Mitte der M_{1+2} oder jenseits derselben stehend' might cause a little difficulty, but this species has the Ta no further back than viciae Kalt., which Hendel includes under his second alternative.

It is probable that this species is related to freyi Hd., lathyri Hd., viciae Kalt. and orobi Hd. The larva therefore may quite possibly be a feeder on some species of *Papilionaceae*.

13, Woodlands Ave.,
Finchley,
London, N.3.
January 3rd, 1955.

HYDRAECIA HUCHERARDI MAB. AND ITS FOODPLANT THE MARSH MALLOW (*ALTHAEA OFFICINALIS*)

By A. L. GOODSON

The species was first recorded from Britain in 1952 when Mr. David Saunders took a ♂ at a street lamp near his house at Hailsham, overlooking part of the Pevensey Marshes, a second ♂ coming the following year, 1953, when a ♀ was also taken by Mr. M. W. F. Tweedie at rest amongst reeds, but in quite a different locality in Romney Marsh. The same year Mr. Hugh Robinson caught another ♂ in his M.V. trap at Dungeness, and later a small party got five ♂♂ on the same spot as Mr. Tweedie's ♀, all at M.V. light. This was enough to convince us that the species was breeding in the area from Pevensey to Dungeness, and not a casual migrant as at first thought. A search through all the Continental text books and periodicals produced no information regarding the foodplant of the larva, indeed, little seemed to be known of the moth itself except that it was confined to marshes in coastal areas; a larva found by Mons. Durel at Honfleur, Normandy, proved to be of this species, but he gave no clue as to what it had fed on.

The foodplant was therefore apparently unknown, and it was with the intention of solving this problem that I, in company with Dr. H. B. D. Kettlewell, went down to the Sussex coast on 28th September, making Winchelsea our headquarters, from whence we could work the marshes either towards Pevensey or in the opposite direction. The day, although sunny, turned cold towards evening, and the chances of getting the moth seemed remote. Our generators were placed along the edge of a disused canal filled with reeds, the site of the original ♀ captured by Tweedie; four Mercury Vapour lights being used, two of them in traps, and my own two over white sheets. To my surprise, despite the cold, two *hucherardi* came to one of the sheets about 50 yards from the Tweedie spot, but higher up the canal Dr. Kettlewell had no luck and we packed up at midnight owing to the rough wind and intense cold, not a moth of any sort coming to the lights after 10 o'clock.

Next morning we started on the real business of finding the foodplant and, arming ourselves with a large spade, went to the canal and proceeded to dig up all likely plants, feeling certain that it would be a root feeder, although owing to the reedy nature of the Tweedie site and the fact that all Continental specimens were from marshy localities, an impression has been gained that it might feed on the stems or roots of reeds. We discarded this idea and thought it much more likely to be similar to *Hydraecia petasitis*, which feeds on the roots of Butterbur, and so were looking for something with a large

substantial root, Dock, Teasel and Burdock were possibilities, but not impressively so. Dr. Kettlewell then spotted a very large plant, well mixed up with nettles and reeds, and with a prophetic air said, 'This is it,' and after digging out the root, a huge affair about nine inches across and almost as deep, it certainly seemed that it might be. This was the Marsh Mallow (*Althaea officinalis*), and subsequent digging brought up roots which had definitely been bored by something, frass being found in one piece, which looked suspiciously large and Lepidopterous. No other plant was dug which seemed at all likely and we went back to our hotel with a feeling of subdued excitement.

The next step was to find out the distribution of the plant; was it only coastal or found in *any* marshy spot? The answer was given to us by Mr. Tabor, the botanist, who helped us greatly; everything he told us fitted in beautifully with our idea, it was coastal, but confined to fresh marshes behind the salt, exactly what we wanted to hear, and we began to feel that we just could not be making a mistake.

That night, I think, was the coldest on record for September and not a moth of any sort came to our lights.

Next morning, working on the assumption that we were right, we touted the marshes looking for larger patches of *Althaea,* since it was not at all plentiful on the Tweedie site, there being only a dozen or so plants in quite a large area. We found a place where there was quite a large growth of the plant, and Dr. Kettlewell's traps were moved to the spot whilst I, with my lights, as a control, would remain on the Tweedie spot. If Dr. K., surrounded by *Althaea,* got more than I, it would seem that the idea was reasonable and our surmise correct.

The night was a little warmer, and on my site I collected four *hucherardi,* but it was not till morning that we could add up results on the other site, since we discovered that the species rarely enters the traps; the insects were all sitting amongst the leaves and grass two or three feet away and difficult to find. We picked up five or six, but must have missed a number, which spoilt the experiment. It was through this that Dr. K. hit on a very good idea; in place of the traps he piled up his egg trays, pyramid fashion, leaving a hole or well in the centre, over which the M.V. bulb was suspended, and amazingly successful it was; *hucherardi* crawls to the light and finally into the trays, remaining till morning even with hot sun shining, the heat not being retained as inside a trap.

We again toured the marshes next day and found three very good sites on which to repeat the experiment, one of them particularly extensive, and Dr. Kettlewell decided to work this one the same night, I still remaining on the canal, although moving a mile or two higher up, where there was more of the plant, but growing singly and not in clumps. This was the night of 1st October, the weather was ideal, quite warm, and by 10 p.m. I was delighted to have taken five or six *hucherardi.* I thought of Dr. K., with such weather it should prove

whether *hucherardi* was commoner where there was more *Althaea*. My hopes were more than fulfilled; when Dr. K. joined me at midnight he had taken 24 specimens and released several worn ones.

I again moved my generator to a rich clump of *Althaea*, and Dr. K. tried his 'egg tray trap' at another spot. The extensive clump of the previous night was covered by a 'plug in' light, making three areas in all, and although the weather had deteriorated somewhat we got a good catch in each, though many specimens were too worn to keep. A freshly emerged ♀ was found by Dr. Kettlewell on a stem of *Althaea*.

After this the wind turned very cold and rough, with a resulting drop in numbers. We had proved the one point which, although fairly convincing, wanted something more concrete to back it up, for instance, the discovery of pupae at the roots of *Althaea* (a rather big 'if' looking at the sort of ground and vegetation; long grass, with matted roots welding the hard muddy earth to the roots, making a substance which was almost impossible to break up). It was worth trying, and, rather to my amazement, we were successful in getting up five pupae, all being found between the grass roots and the top of the *Althaea* root, roughly four to five inches below the surface. Four of these pupae were damaged by breaking up the mixture of roots and mud, but one was intact and produced a crippled ♀ after we returned home, the final proof we needed. Further evidence was furnished by two ♀♀, each kept in a separate tin, with muslin cover, one supplied with *Althaea* seed heads and pieces of root, the other with Burdock, Dock Reed, etc. The one with *Althaea* laid eggs on our way home, the other refused to do so. Later, at Tring, the latter specimen was put on *Althaea* and she then obliged readily. The eggs, as expected, are wintering as such, a supply of plants has been brought home for next year's work—that of finding if the young larva starts eating the stem or the root. The eggs from these females, being mostly on the sides of the tin and the muslin, were not of much help in this respect.

The moth flies very low amongst the foodplant and so gets worn very quickly. I saw it flying only three times during the week, and this away from the lights. On the sheet it is very lethargic, but at times, in a box, it will suddenly run like a mouse with incredible speed, reminding one of *A. tragopoginis*. On the best night, 1st October, a number were eaten by what must have been Lizards, as, on moving the egg trays, we found three of these creatures, and just the wings of *hucherardi*, no *c-nigrum* had been touched, although in hundreds in the trays.

So ended a most enjoyable week. It is hoped that, as a result, collectors will look for the moth in other localities which have the foodplant and so give us an idea of the distribution of *hucherardi* in these islands.

26 Park Road, Tring.

A NEW ABERRATION OF *HYDRAECIA HUCHERARDI* MAB., (LEP: CARADRINIDAE)

By A. L. GOODSON

Illustrated on Plate TWO.

Hydraecia hucherardi Mab., ab **fuscoquadrata, ab. nov.**

Forewing with the reniform itself and the space between its outer edge and the postmedian line, heavily dusted with fuscous, forming a decided, dark scaled square.

The postmedian line curves well inwards towards the reniform instead of proceeding in a straight line from the inner margin to the costa, the only place where, in normal specimens, it is bowed.

The specimen, a male, was taken near Rye, Sussex, on the 3rd October, 1954, by A. L. Goodson.

Type: In Rothschild-Cockayne-Kettlewell collection at Tring.

NOTES AND OBSERVATIONS

TATHORHYNCHUS EXSICCATA LED., IN KENT; THE THIRD BRITISH SPECIMEN (LEP: CARADRINIDAE)

On a recent visit to Dr. G. A. N. Davis, of Aylesford, near Maidstone, Kent, I was shown a number of Micro-lepidoptera that he had set on one side for determination. Among these was an example of what appeared to me to be the Macro-lepidopteron *Tathorhynchus exsiccata* Lederer (Levant Blackneck); a species with a wide distribution abroad, but which had only twice previously been recorded from this country. I have since had the opportunity of submitting this specimen to Mr. D. S. Fletcher of the British Museum (Natural History), who kindly confirms that it is this species.

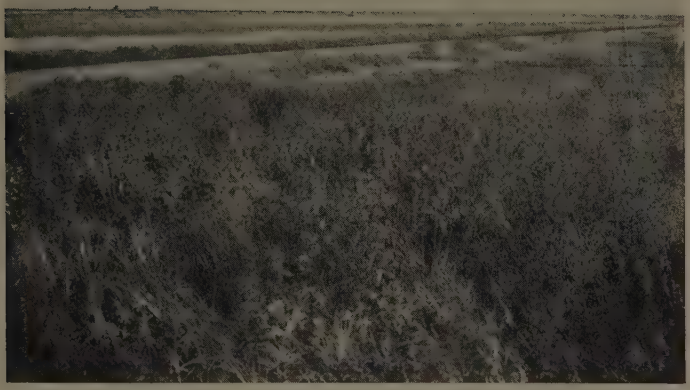
The moth is a male, in fairly good condition, and was taken by Dr. Davis from his M.V. light trap in his garden at Aylesford. He tells me he cannot say exactly when, but it was either in 1951 or 1952 that he took it.

The other two records of *exsiccata* for Gt. Britain are as follows: (a) One at Maidencombe, S. Devon, on 20th March, 1952, by F. H. Lees (*Ent. Record* **64**: 131); (b) One at Alton, Hants, on the night of 21st-22nd March, 1952, by H. S. Robinson (*Proc. S. Lond Ent. & Nat. Hist. Soc.*, 1952-3: 5).

The moth is clearly an immigrant, and it is reasonable to suspect that the Aylesford example came over with the other two.

J. M. CHALMERS-HUNT.

70 Chestnut Avenue,
West Wickham, Kent.



Typical ecology of *H. hucherardi,* Mab., with the 'Marsh Mallow' growing in masses in the foreground. Romney Marsh, Kent.

Hydraecia hucherardi Mab.
ab. **fuscoquadrata** Goodson, **ab. nov.**
(Natural size.)

A normal specimen of *H. hucherardi* at rest on Reed.
(Photograph by J. D. Bradley.)
(Enlarged.)

THE BREEDING LOG OF AN *APATURA IRIS* IN 1954

By I. R. P. HESLOP, M.A., F.R.E.S.

ALTHOUGH I first took the Purple Emperor (*Apatura iris* Linn.) in 1935, it was not until the present year, 1954, that I first achieved my cherished ambition of breeding it.

This was a matter for careful preparation. In 1952, shortly after my retirement from service abroad, I set about establishing a stock of growing foodplant, viz., the Broad-leaved Sallow (*Salix caprea*). The Purple Emperor caterpillar feeds on both this and the Narrow-leaved species (*Salix atrocinerea*), but there is no doubt that the preference is for the former in most localities. There are, however, many varieties and hybrids of *Salix*, and what is certain is that the larva will not tolerate any of the *short*-leaved forms. The leaf must be long enough to take the full-sized larva at full stretch. The discomfort of a larva on a leaf too short for it, but imposed upon it in captivity, is painfully obvious.

There is no doubt too of the superior advantage of having a growing foodplant. But all the Sallows (unlike Common Willow) are very difficult so to establish. I found that the survival rate of both cuttings and dug-out seedlings was not more than four or five per cent. The best results were achieved by 'stemming,' i.e., by keeping cuttings in water until they had become furred with rootlets, and then sifting fine soil round them in pots. In this way as many as twenty or twenty-five per cent took root: but half of these died in the following year.

S. caprea does not grow in any quantity nearer than about twenty-five miles from here (Burnham-on-Sea). However, by 1953 I had a sufficient number of vigorous potted plants of this species; and I addressed myself for the first time to beating for *A. iris* larvae. A total in May and June that year of 23 hours in the Wiltshire woods and 4 in the Somerset woods produced no result .

However, endeavour had its reward on 17th May this year, when after a total of 14 hours beating in the Hampshire and Sussex woods in the company of the Baron de Worms, and at the very last moment of my allotted time, I beat a half-grown Purple Emperor caterpillar off a bush of Broad-leaved Sallow. Briefly to summarize its subsequent history, this caterpillar underwent its last moult on the following day, 18th May; pupated on 14th June; and the perfect insect emerged on 10th July.

My opportunities for watching the development of this example were exceptional. And it is the facts of this observation that I offer in the accompanying 'log.' The present commentary is not intended to constitute a complete re-statement of all the data: further details and further features (e.g., references to 'spinning' and to 'pulsing')

will be found in the log. Although the life history of this species has of course long since been worked out, I hope that the details of the frequent and regular check that I was in a position to make may be interesting as well as perhaps yielding some new data. I should mention that pencil, paper and magnifying glass were always kept on the bench beside the cage. The cage itself was an outsize job made to order for me by one of our local craftsmen. All times given are by British Summer Time.

It is appropriate, in view of what is related below concerning the larva's feeding times, to notice that sunset at Burnham-on-Sea, Somerset, on the day of the caterpillar's arrival there (18th May) was at approximately 9.0 p.m. (B.S.T.), and on the day of pupation (14th June) at approximately 9.30 p.m. (B.S.T.).

Quite apart from the chronological presentation herewith, certain features call for comment or analysis.

The time spent in the chrysalis, 26 days, was quite out of the ordinary. I attribute this fact entirely to the extraordinary weather. It has been suggested that the pupa should have been given more sun; but quite apart from the fact that there was very little anyway, both the larva and the pupa were welcome to all there was.

The large cage, with celluloid all round, and particularly well ventilated both above and below, was placed on a bench which had been designed for the purpose at one end of my roomy garage. It stood before a set of large glass windows (facing south) which were opened in close weather, and under a transome which was kept open day and night (except on two or three occasions when a salt wind was coming off the sea seventy yards away). It was entirely protected from rain; but necessary moisture was supplied by other means as is detailed below.

The garage has two electric lights, one being fitted with an ordinary bulb and the other with a special daylight one. During the larval stage only the former was used for inspection, and then only during hours of darkness: it was not left on. The latter (i.e., the daylight one) was not used at all between sunset and sunrise: but it was lit on two or three occasions during the day when it was feared that the caterpillar might be suffering from lack of ultra-violet light during this gloomy summer. It was felt that there was always the daylight bulb in hand as a possible stimulant in the event of a recurrence of such a deep and curious torpor as that of 22nd May: but in any case the feeding of the larva gave no cause for anxiety thereafter. There was only one instance of apparent reaction to artificial light, as recorded in the log for 9th June:' and even this may have been co-incidental.

During the pupal stage neither light was kept on longer than was necessary for observation. In the later part of the pupal stage the daylight bulb was of advantage in permitting an estimate to be made during night-time of true colour changes, etc.

The cage was at first placed on a portion of the bench which nor-

mally received full sunshine for several hours each day. But the caterpillar proved quite intolerant of this, sheltering itself under leaves at the very bottom of its bush in very evident distress (21st May). I then moved the cage to a portion of the bench which, owing to a tree outside the windows, at that period received dappled sunshine only. Here the caterpillar throve. But the observation noted received confirmation later (7th June).

As the caterpillar increased in size it was placed on larger bushes, three being used altogether. At first I found the caterpillar very difficult to spot even on a very small bush. Later, with the practice I had had and as my eyes became used to it (a point perhaps worth noting by searchers), I was able to spot it quite quickly even on quite a large and exceptionally leafy a bush. Once it was on its final bush, a particularly luxuriant one, the cage was never moved at all: so that the caterpillar had an opportunity to make a sure selection of its place for pupation. This, after much exploration of every part of the bush, was at the upper part thereof—a site which was always in shadow. Nevertheless, twenty-two days after the pupa was formed, I put the cage on a table outside for half an hour in the direct morning sunshine (6th July). This was actually the only morning of sustained sunshine during the whole pupa stage! The cage was directly afterwards replaced exactly on the marks I had made, which showed its position and orientation.

Actually, all stages under observation occupied much more time than normal. From last moult to pupation was 27 days instead of the normal 20. The pupa state occupied 26 days instead of the normal 15. But what is perhaps even more remarkable is that the time taken from fixing for pupation (i.e., when the caterpillar turns head downwards for the last time) until the commencement of the act (i.e., when the caterpillar 'swings clear') was almost exactly 72 hours as opposed to the usual 48.

There is no doubt in my mind that these delays were a reflection of the general weather. The perfect insect eventually emerged on Saturday, 10th July. Despite the closest watch in the woods both by my wife and myself and by the gamekeeper, the first wild specimen was not seen until 12th July. In 1953, which was a later season than average, the first wild specimen was observed in these same woods on 7th July. And in 1952 in the same place some specimens were already getting worn on the 5th. Reverting to 1954, it may be added that a perfectly fresh male was seen this year on 7th August. The last specimen actually observed in 1954 was on the 11th, but I think that the species might have continued on the wing this year until the last week of August, if it had not been for an early frost in this area on 13th August: (it may be mentioned that there had been a 'late' one on 5th July!).

Quite apart from frosts and lack of sunshine, it is instructive to note that in this summer of almost daily rain *not once* was my cater-

pillar, despite constant observation, seen to eat at all while it was raining outside. I cannot find any record of a similar observation; and the phenomenon, if confirmed, may be of importance towards our study of the species. As stated previously, the cage itself could not be reached by rain: and yet as soon as the drops started to come down outside the caterpillar, if it was already feeding, ceased to do so. It did not appear to be a matter of barometric pressure; since the caterpillar would eat when the glass was very low indeed, provided it wasn't actually raining.

The caterpillar generally fed in irregular snatches, but very voraciously and rapidly when it did so. In fact it had only one regular feeding time, but this could be relied upon; and that was at some time shortly after 9.0 p.m., i.e., about and after sundown (range of time of this given above). Only twice, on 23rd May and 7th June, was there a break in this timetable subsequently to the recovery from the last moult and prior to fixing for pupation: and then it was raining. When the rain ceased between 11.0 and 11.30 p.m. on 23rd May, the caterpillar started in at a rate which showed that it was anxious to make up for lost time. As it happens, these were the only occasions during my investigation when it was raining at the 'regular hour': but although, of course, there were many fine periods on nearly all days, it did not follow that the larva would eat therein. The main deductions then are:—(a) After 9.0 p.m. was the only regular feeding time (and that provided it was fine at the time), and (b) There was no feeding at any time during rain.

Anatomically the caterpillar is particularly well adapted to damp. And clearly when in confinement it must have a fair amount of moisture for proper development to take place. In my case, the caterpillar and its bush were once sprayed by means of running the thumb-nail down a clean tooth-brush dipped in tap water (probably rain water would be better). This would have been done more often if the atmosphere outside had not usually been so very damp anyway, or if the pot had not been kept watered. But the interesting feature is that when this fine spraying was done (29th May), the caterpillar was actually observed drinking eagerly from a large drop formed on its seat leaf. The chrysalis was similarly sprayed on three occasions (30th June, 3rd and 6th July). When this was done, so soon as enough fine spray had been imparted as to cause actual droplets to form on or near the chrysalis, it shook itself like a dog. Indeed, with such violence was this startling act performed as to shake the entire bush.

Throughout the process of breeding the plant was kept regularly watered. The caterpillar obviously needs a healthy growth of pabulum; and as regards the chrysalis, I feel sure that this itself would die if the leaf on which it was formed should wither.

The caterpillar was at first placed on a very small growing plant indeed, so as to facilitate observation. It very soon became apparent,

however, quite apart from the fact that he was rapidly eating it up that this did not give him the freedom of movement that he needed. In fact, it became obvious to me during the process of breeding that the caterpillar needs, and will take, all the exercise it can get. The activity of the larva, when unrestricted, is phenomenal: as its grace and flexibility of movement are unsurpassed.

The effects of the lack of exercise were speedily demonstrated when my caterpillar was placed on his second bush. This elevation he celebrated by falling off twice on that very day (25th May) on to the earth of the pot; and again, this time on to the floor of the cage, on the night of 26-27th. I was afraid at first that he was sick and that I should lose him; but with the additional scope for exercise that the second bush presented, the caterpillar's strength was enhanced, and there was no more falling off.

But as the caterpillar grew, so it became evident that the foliage of the second bush, though of *Salix caprea*, was of too short-leaved a strain to suit it. The discomfort of the caterpillar was obvious. And on 29th May he was transferred to his third and last growing bush—a specimen plant of unusual luxuriance of foliage and size of leaf. This at the outset he explored thoroughly, climbing to every pinnacle he could see apparently just for the joy of it.

In the early part of his career with me the caterpillar had always ceased feeding when his cage was approached. If the cage were touched, he jerked and then 'froze' into a defensive (and prehensile) attitude for several minutes at a time. It is a strange and rather touching fact, however, that on the occasion of his second fall he accepted my proffered forefinger to crawl on to for replacement on his bush. Later he became completely accustomed to me, not abating from his normal activity in the least when I attended to the cage or plant. And when he was transferred from one bush to another, he even ate eagerly of the very leaf on which he was being conveyed.

Foreseeing the possible effects of a fall, I had from the outset covered the floor of the metal cage with a half-inch layer of clean sand. And there was also a coating of sand on the soil of the pot in order to facilitate cleaning thereof. After his first fall, however, on to the surface of the pot, the poor caterpillar was found in a most frightful mess, really rather reminding one of 'rag-worm' bait, of adhering sand grains and strands of silk fibre. This took a good twenty minutes to clean off with a soft water-colour brush, the while the docile creature was gently steadied with a finger of my left hand. I was quite sure that a fall to the floor of the cage (which did in fact occur later) would result in serious injury, without there being a shock-absorbent layer: but on the other hand the risk of clogging with sand could not again be tolerated. So both the layer on the floor of the cage and the coating on the pot surface were replaced immediately with fine dry loam. This, however, became rather miry with

subsequent watering of the plant: and it is probable that very finely ground peat would be best for a future occasion.

Reverting again to the subject of proclivity for exercise, I am aware that specimens of normal or even of above-average size may be obtained by rearing on cut sprigs in water, or even on leaves in air-tight tins. But there may be other criteria by which the value of the fact indicated may be measured: for example, by the avoidance of the dwarfed individual that is apt to crop up all too frequently among bred specimens, by the production of a firm texture of wing (since the setting of a flaccid specimen is even more nerve-racking than that of a normal one!), by the avoidance of a tendency to stick to the setting-paper and, potentially, by the notion of procuring a pairing in captivity—should that feat, so very rare with *iris*, be attempted.

I have mentioned that three separate bushes of *S. caprea* were used in succession. It must be stressed, however, that in all cases the foliage was tied or trimmed back, so as to render the walls of the cage out of the remarkable stretching reach of the caterpillar. I have no doubt at all that prolonged sojourn on the lifeless celluloid would have deleterious effects; and an act of moulting or of pupation (or, in other cases, hibernation) affected by these walls might well end in disaster.

For feeding, the caterpillar always chose a leaf which, when bent down by his own weight, would show the upper surface towards the outside of the bush. As he grew larger he would choose for his seat leaf, which he would change periodically after having a last meal off it, one which grew from a more or less horizontally lying stem. It appeared that since his weight made the leaf pendent anyway, there was less risk of the leaf snapping off if it were bent down only from the horizontal (i.e., say through 90 deg.) than if it had to be bent down from the vertical or nearly so (i.e., through an angle approaching 180 deg.).

Frohawk ('Natural History of British Butterflies' and 'Complete Book of British Butterflies') states that the larva usually chooses the underside of the leaf for the last two moults. This was not so with my caterpillar so far as the last moult (the only one covered) was concerned. In fact, the only time, apart from when he was preparing to pupate, that I saw him on the under surface of a leaf was on 21st May, when he was desperately trying to shield himself from the sun.

Frohawk describes the caterpillar as 'a day feeder.' If this means that it does not feed at night, then this was certainly not true of my specimen. I have described how my Emperor larva always had his one regular meal after sundown. Not only this, but, as will be seen from the log, he frequently continued to feed on into the dead of night. And although I am an early riser, I sometimes found that he had taken another substantial meal before my first inspection. On the whole I think that my caterpillar ate more between the hours

of 7.0 p.m. and 7.0 a.m. than he did between 7.0 a.m. and 7.0 p.m.

Artificial light appeared to have no effect on feeding habits. I have described the lighting arrangements above.

One curious feature was that the left horn of the caterpillar was considerably shorter than the right. He had this feature both before and after his last moult. A sketch from life of the larva was made on 3rd June. This sketch is preserved in my collection; together with the actual skin cast on pupation, in witness of this fact. Fig. 1 is a photograph of this cast skin (linear magnification = x4).

Fig. 1. Cast Larval Skin, 14th June, 1954.

The left horn was not truncated in any way. Its tip process was quite perfect: the horn just was shorter than the other. This asymmetry was reflected only very slightly in the pupa, and not at all in the imago.

I regret that I did not measure the larva on beating on 17th May, i.e., the day before the last moult. But on 27th May the length when slightly humped was 35 millimetres; and when lying full length (but not crawling) 38 mm. And on 8th June, when lying seemingly deliberately fully stretched out (probably as a preparation for pupation) on his seat leaf, the caterpillar measured approximately 45 mm. in length, which I think was a greater extension than I saw at any other time save when he was reaching from one leaf to another. All these measurements include the horns.

I may suggest that if, as is sometimes implied, the qualities of inquisitiveness and even of intelligence may be attributed to the perfect insect: then they are no less applicable to the larva. I always had a sensation, as I have had previously only with the Praying Mantis among insects, that I was being watched as an individual by that caterpillar! And this sensation was never more vivid than at the moment when I saw him move, as a caterpillar, for the last time: when on the evening of 11th June he turned head upmost for the

last time, paused, and took a last look round, and then a minute later turned head downwards in fixation for pupation.

I had the great good fortune to see in their entirety the processes of the last moult, the double reversal of position immediately prior to fixation for pupation, and the actual process of pupation itself. It must be rare indeed that one observer can see all these phenomena in toto and in the one specimen; since such depends on his being on the spot just at the right second each time—a matter of luck more than anything else. I did not see the process of emergence, which took place in time for the insect to have his wings fully expanded before my first inspection of that day at 6.15 a.m.; but I hope I may see an emergence of this species at some future date.

The last moult took place (18th May) on a spray held in a phial charged with damp cotton-wool and contained in a large breeding-tin on the cushioned seat beside me in a compartment of the train from Waterloo to Templecombe on my way back to Burnham. I came from the restaurant car just in time to see it start. And I didn't take my eyes off the caterpillar until the conclusion of the process. Consider too that the 'double reversal' (11th June), which lasted for a bare quarter of an hour between periods of practical immobility of 29 hours and 72 hours, might so easily have been missed between visits.

And then again, after many previous anxious inspections, but ultimately just after my return from several hours of absence, I actually saw the 'swinging clear'—after those 72 hours of quiet—which signalised the commencement of the act of pupation (14th June). And thereafter my fascinated eyes never left the specimen until after the completion, 64 minutes later, of the wonderful process. I have seen other species pupate: but this was one of the most marvellous of all things I have ever seen in my life.

In watching the changes during pupation, I twice noted a very remarkable phenomenon: that of a sudden and temporary pallescence of the specimen. I do not think that the observation was subjective to myself; but I would welcome confirmation nevertheless. These phases lasted from 1½ to 2 minutes. There was also a longer period, perhaps a quarter of an hour, of progressive pallescence just before the 'swing': in fact, it may have been this that engaged my attention, so that I actually saw the 'swing' and the ensuing act of pupation. What the significance of these profound and critical pallors may be I have no idea, but they will be found recorded in their chronological places in the 'log.'

Incidentally, is it possible that the fully formed and hardened pupa has a slight degree of luminosity? This is an interesting point. The pupa is of course very pale in any case; but on a very dark night I could see it faintly through the closed window of the garage and the celluloid cylinder of the cage at a moment when I could see nothing else at all—not even the open pages of my notebook

lying on the bench beside the cage. The phenomenon, if it has any reality, would probably best be measured and recorded by means of special photographic plates. This is just a query I am posing: it is not a statement.

There is one special observation which was instrumental, however, since it depended on simple measurements. I do not know of a previous record of any such observation. This is the feature of 'elongation' of the pupa. It is necessary first to describe the general change of shape during pupation. The outline of the pupa, viewed laterally, is roughly triangular. In Fig 2 the completed pupa is represented by the whole figure, viz., ABC; where CA is the ventral side, AB the dorsal side, and CB the 'capital' side (I am coining the term for the occasion).

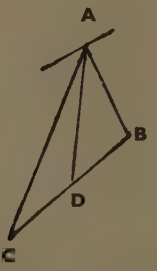


Fig. 2. Diagram of Formation of Pupa, 14th June, 1954.

In the intermediate stage, however, perhaps half-way through the hour of pupation, the shape is as in the sub-triangle (ABD); so that the dorsal side (AB) is longer than the capital side (DB), and the main bulk is in the anterior or pendent half of the subject. But as development progresses, the capital side (CB) becomes longer than the dorsal side (AB) and the main bulk is now in the posterior half, i.e., towards the point of suspension at A. So the sub-triangle (ADC) represents the second instalment of the change of shape: but note that the sub-triangles in the figure are not intended to be actual size.

But what is more remarkable is that there was a *subsequent* elongation of the pupa at C. This was in no way dependent on the length of the horn points, which remained constant. At 8.45 p.m. on the day of pupation, 14th June, when the pupa had taken proper shape, the length (AC) was 28 millimetres. But by 7.0 p.m. on the following day C had obviously extended beyond a certain fixed point. Elongation, also a general swelling, continued on the next day (the 16th), but after that was not so apparent. When next measured, on 21st June, the length (AC) was 30 mm. And I was really surprised on measuring the chrysalis again on 6th July to find that the length (AC) was now 32 mm.

I am aware of course that actual growth, i.e., increase of weight, cannot have taken place; since there was no intake by any means that we are aware of. The elongation (which was not accompanied by any slimming) must have been simultaneous to some internal compensation.

It is interesting to notice the other measurements of the pupa. I must point out first that the measurement given in most books as the 'width,' is not the width at all, but the *depth* (i.e., as measured in a ventro-dorsal dimension). I make this clear in the following measurements made on 21st June:—

Length	30 mm.
Depth (i.e., ventral surface to dorsal ridge, at maximum)	13 mm.
Width (lateral)	7 mm.

Another point to which I must allude is the angle of suspension of the chrysalis when seen from the side. It is a custom to figure the chrysalis as hanging with its ventral surface in a vertical line. This is not my own observation: and my chrysalis had the freedom to form and develop naturally. I found that my chrysalis hung as one would naturally expect it to hang, i.e., with the line of gravity forming the vertical. Fig. 3 is a photograph (natural size) of a drawing that I made from life of the pupa on 21st June.

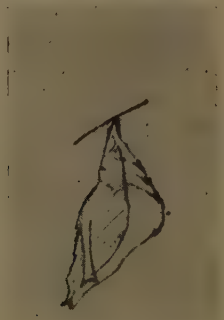


Fig. 3. Pupa.

This sketch I deliberately made from exactly the same lateral angle as that from which the figure in 'South' is shown, and my own figure may therefore conveniently be contrasted therewith.

I may mention that I might have become anxious about the length of time spent in the pupa, as did several of my friends; had not the chrysalis been in such a position that, through the remarkably transparent envelope, I could see directly through it against the light. Thus, helped with a lens, I could in the later period daily satisfy myself of the continuance of internal development. If there had been

any doubt as to the maintenance of health and strength, however, this would in any case have been dispelled by the remarkable reaction, already described, to spraying!

I may add also that the garage in which my experimental bench was situated had to be used daily for the purpose for which it was intended. When starting up or driving in the car all doors and windows were first thrown open to the fullest extent so as to prevent any collection of fumes. Nevertheless the noise and vibration of the engine at first occasioned considerable alarm and despondency to the caterpillar, so that for a couple of nights I deemed it prudent to leave the car on the ramp outside. Very soon, however, the caterpillar ceased to take any notice at all of the disturbance: and would not pause in a meal even if the engine were being 'revved up' slightly.

The imago, a normal male, emerged on 10th July. Few events have ever occasioned me more satisfaction.

Log-book

17th May: Monday. Purple Emperor caterpillar beaten off a bush of *Salix caprea* by self at 4.15 p.m. in a Sussex wood after 14 hours beating (two days). Fairly active in tin at first, but had probably already gone into 'set' before being beaten. Lethargic later.

18th May: Complete torpor. Moulted 2.0-3.0 p.m. (during train journey between Waterloo and Templecombe, but observed throughout); ate nearly all of shed skin. Very active for short time, but did not eat food plant so far as could be seen; settled down later. Resting completely.

19th May: Two frass pellets from previous night. Larva placed in a special large cage on small growing plant of Broad-leaved Sallow (*Salix caprea*). Finished rest and commenced feeding (starting with very young leaves) at 11.0 a.m. after glimpse of sun. Ate in snatches. Ceased about 4.0 p.m. Pellets normal.

20th May: Commenced feeding 10.30 a.m., without sun. Fed further during morning, but not in afternoon. Ate another leaf after 9.0 p.m. Pellets normal.

21st May: Sheltering from sun: cage moved to shade 10.30 a.m. Was watched voiding pellet 10.55: process took half minute. Quiet. Became very active in dappled sunlight 11.15, moving position several times. Commenced feeding 11.30. Started further feed 5.0 p.m. At 9.0 p.m. found to be in middle of another hearty meal. Ceased feeding and became still 9.10 p.m.

22nd May: In state of deep torpor all day. Scarcely perceptible reaction to blade of grass on horns. Blowing produced a very slow movement of the head and anterior part. Blade of grass brushed along side of thorax produced a lunge sideways of the head. Moved from seat 9.38 p.m. Commenced feeding 9.40 (one whole young leaf consumed). Returned to seat some time before 11.30 p.m.

23rd May: At 7.0 a.m. was found to have consumed nearly the whole of 'seat' leaf during remainder of night and to have taken up a new 'seat.' Found feeding again 4.50 p.m. On seat when next seen, 6.0 o'clock. Raining: no further movement or feeding observed by 11.0. Feeding hard at 11.35 p.m.: fine.

24th May: Dull, rainy and cold. Larva torpid until some time between 4.30 and 5.15 p.m., when found feeding. Ate sporadically until just before 7.30. (Daylight bulb on between about 4.0 and about 7.30). Started moving at about 8.50 and feeding at about 9.0 o'clock. At rest when next observed, 10.30. On seat when last seen, about 11.15 p.m.

25th May: Dull, rainy and cool. Larva torpid. Fed a little about 11.0 a.m. Again torpid. Was deliberately awakened and removed to new bush about 1.0 p.m. Immediately fed voraciously for some time. Explored. Then sat up on highest part. Found walking about on sand layer of pot at about 2.30. Cleaned and replaced. Wandered restlessly about, but did not eat again before setting up at about 6.0 o'clock. Subsequently again fell off and was replaced. Found feeding voraciously at 9.20. Found quiescent 10.30 p.m.

26th May: At rest when observed at 7.0 a.m. I was out all day. Larva in same place and quiet when next observed at 7.45 p.m., but had apparently eaten a little more of this leaf. Started to feed some time between 9.0 and 10.0 o'clock, and was observed feeding voraciously at latter time. Settled down at 11.14 p.m.

27th May: At rest, but in different position (on stem), when first observed at 7.0 a.m. Judging by marks on earth on floor of cage, had apparently fallen off again—this time right to the bottom. Started to wander shortly after first observation, and still wandering at 9.30. Very noticeable that when cage moved even gently, caterpillar ceases moving and grips on tightly for several minutes. Caterpillar very restless all day. Observed to feed rapidly 2.55-3.0 p.m. (almost a whole leaf); and 3.40-3.45. Settled down about 4.30. Still at rest at 7.27. Measured. Length (slightly humped) 35 millimetres, including horns: lying full length (but not crawling) 38 mm. ditto. Found at 9.20 feeding vigorously. Ditto when next observed, 11.30. At rest when next (and last time this day) observed, 11.50 p.m.

28th May: Dull and wet all day until evening, when rain ceased. Completely torpid until found feeding at 9.15 p.m. rapidly. Found feeding rapidly also on two subsequent visits, 9.50 and 10.30 p.m. At rest when next observed, at 12.30 a.m.

29th May: Quite quiet until observed moving about at 2.30 p.m.: I think had fed a little. Transferred to larger plant 3.0 o'clock. Bush was sprayed lightly: caterpillar drank. Wandered about restlessly and fed a little. Took up new seat 3.45: resting. Eating avidly when observed at 9.10 and 9.45. Quiet when next observed, 10.15 p.m.

30th May: Found to have eaten further during the night (a whole large leaf), and then to have returned to same seat as before. Quiet. But took a hasty snack at 11.13 a.m. and again at noon (just before I went out). I returned at 5.15 p.m. to find that he had made a further quite hearty meal from his seat leaf: but was now quiet again. Further snack some time between 6.0 o'clock and 7.0 o'clock. Observed moving at 9.10, when also had eaten a little. On fresh seat at 9.45 and again at 10.30. Feeding furiously (on fresh site) when last observed at 11.25 p.m.

31st May: Found in morning, 7.0 a.m., on different leaf again. Quiet. Quiet also at 8.30. Feeding hungrily on seat leaf at 9.10. Moving about at 11.30. At rest (on stalk) 11.54. No further movement (despite inspection two or three times hourly) until 7.27 p.m., when observed feeding eagerly. At rest when next observed, about 8.0 o'clock. Commenced moving again at 9.37, when also ate a little. Commenced feeding again 9.46, at first slowly and then rapidly. Quiet when last observed, at 11.50 p.m.

1st June: Caterpillar resting when first observed, at 7.0 a.m. Self out all day. On my return (7.45 p.m.) found at rest, but had obviously been eating extensively. Found eating voraciously at 10.07 (and to have been eating for some time). At rest when next seen, about 11.0 p.m.

2nd June: At rest until 10.20 a.m., when started eating. At rest again when next observed, 10.40. Seemed to be spinning threads on fresh leaf at 1.0 p.m. But had returned to previous seat and was quiet when next observed, at 2.0 o'clock. Moving restlessly at 6.55. At rest (at top of stalk) at 7.40. On rib of remains of neighbouring leaf (four-fifths eaten) at 8.02. Found feeding at 9.30: stopped by 9.35—apparently a snack only. Found eating furiously at 9.55 and continued doing so until moved ground at 10.05. At rest when next (and last to-day) observed, 11.30 p.m.

3rd June: Caterpillar very restless all day, sometimes resting head-up on leaf or stalk and sometimes head-down. Observed to feed only once during these wanderings: at 4.40 p.m. for a few minutes. Settled down on mid-rib of a well-eaten leaf at about 6.0 o'clock. Found feeding vigorously at 9.35 and so continued until 9.43 p.m. Sketch made to-day.

4th June: Motionless and torpid all day until at some time after 9.15 p.m. (when observed still in statu quo): (I was out from 11.30 a.m. to 7.10 p.m.). When next observed, 9.30, had moved position and was eating rapidly. Had ceased at some time before 10.0 o'clock, when again seen motionless. Eating again when next observed, at 10.45. At rest once more (on leaf on which had started day) when next (and last) inspected, 11.30 p.m.

5th June: Quiet until observed feeding rapidly at 11.05 a.m.: still doing so at 11.24. Crawling back on to seat leaf at 11.45. Had turned round (i.e., head up) and was at rest by 12.0 noon. Found

eating furiously again at 2.39 p.m. Had retired to seat again by 2.47, when next seen. Found feeding vigorously at 3.52. Ceased feeding and returned to seat (head downwards) 4.07. Reversed into normal position 4.10. Remained there during subsequent observations; until that at 7.40, when it was found to have moved and just be finishing a meal. At 8.40 found to have returned to seat. Still there at 9.25. At 9.36 seen to be feeding voraciously. Still feeding at 9.43. At rest (not on seat leaf) when last observed, at 11.22 p.m. A substantial pad was noticed on the seat leaf for the first time to-day.

6th June: Raining. Found at 7.15 a.m. at rest on seat leaf in usual position. At 10.43 found on same leaf, but reversed (i.e., with head downward): had been nibbling seat leaf (it had been fine for a few minutes about 9.0 o'clock). Between 10.52 and 10.53 larva turned head upwards again. Still at rest on seat at 1.06 p.m. At 3.49 found to have been again eating seat leaf (it had been fine since about 3.0 o'clock). Found at rest on seat leaf on each of several subsequent visits, last of which was at 8.50. On next visit, 9.25, was feeding on another leaf: and was still doing so at 9.43. Found eating on next visit, 10.10: and was still eating at 10.19. At next (and last) visit, 11.05 p.m., was at rest on seat leaf.

7th June: Raining most of day. When first seen at 8.0 a.m. larva was at rest on seat leaf. During sunny period seat leaf came into direct rays of sun (of which there hadn't been any in the morning lately), at about 9.30. Larva moved to shade at 9.46. Commenced feeding 9.54. Still feeding at 10.10. At rest 10.26. At rest, head downwards, on another leaf 11.30. On same leaf (now new seat leaf) at rest in normal position 11.44. At 12.0 noon, 12.30 p.m., 12.54, 1.24, 1.32: ditto. Eating furiously at 1.57. At rest (upside down) at 2.22. Ate a few mouthfuls at 2.25. At 2.27 started to move to fresh leaf: moving completed by 2.29: resting. Resting on each of several subsequent observations, last at 4.50. At 5.53 found just completing a meal of a whole leaf, leaving mid-rib only. Moved off immediately to another leaf to rest, head outwards. No difference at 5.58. By 6.06 had turned round, with head to stalk. Solid rain in evening: and no movement or feeding of caterpillar, though observed frequently until 11.30 p.m.

8th June: When first observed at 7.0 a.m. larva was on different leaf from that on which last observed on previous evening, and had been feeding during the night. It was a sunny morning, but there was no movement of larva (despite frequent observation), until it was found feeding ravenously at 11.31. At rest when next observed, 12.40 p.m., but had consumed the entire leaf (except mid-rib). Found feeding hard on another leaf at 3.35. Just finishing last remnants of leaf adhering to mid-rib at 3.44. At rest on seat leaf at 3.53. At rest during each of several subsequent observations up to 9.0 o'clock. Found eating at 9.37: still doing so at 9.45. At rest

on seat leaf at 10.56 p.m. While at rest longitudinally on his seat leaf to-day the caterpillar seemed deliberately to exercise his remarkable powers of stretching, so that his horns overlapped one end of the leaf and the tip of his tail the other. While so postured he measured approximately 45 mm. in length (including horns).

9th June: Raining continuously all day. Larva torpid on seat leaf. No movement whatever until 9.39 p.m., when it started to leave seat leaf. At 9.43 it started to eat a little during temporary stoppage of rain. The electric light was first used to-day for inspection at about 10.15, and when it was switched on the larva immediately returned to seat leaf and rested head downwards. Larva reversed itself at 10.25: faint movement of head observable thereafter, but this soon stopped. No further movement.

10th June: At 7.0 a.m. found to have been nibbling a little round edge of seat leaf during the night: at rest on seat leaf. Torpid during all subsequent visits until 12.40 p.m., when it commenced to move. Wandered about restlessly until 12.50, when it started to eat. Ate until 12.58, when it began to move about restlessly again. Still doing so at 1.06. At rest on stalk (horizontal) at 1.30. Found at 2.05 in position *under* leaf (head uppermost): this was the seat leaf.

11th June: Motionless (head uppermost still) all day. Viewed at frequent intervals during the day: no change, except that the head was raised a little from about 6.30 p.m. Between 7.0 o'clock and 7.23 (process seen, but exact time not noted) reversed itself, i.e., got into head downwards position (still on under side of leaf). Watched him turning head up again at 7.24. Head downwards once more at 7.25: still under leaf. Spinning all the time from 7.23 to 7.25. Numerous other inspections until after midnight: no change.

12th June: 7.0 a.m., found as before: crystaline appearance progressed.

13th June: Progressive paling and transparence, giving the effect of the 'ribs' showing through. At 10.33 p.m. slight movements. Perceptible space between forepart of caterpillar and leaf, 10.50. Space much widened at 11.16. At 11.50 p.m. and numerous subsequent visits no perceptible further movement. Last inspected at 12.16 a.m. before I went to bed.

14th June: Monday. 6.50 a.m., forepart back in proximity to leaf again, though not quite touching. When seen at 7.30, 7.55 and 8.21: no change. At 8.50, 9.0 o'clock, and thence every half-hour until 11.30: no change. I then went out: returned at 6.45 p.m. At about 6.50 progressive pallescence commenced. Larva almost colourless at 7.0 o'clock. At 7.06 'swung clear,' suspended now only by the tail. At 7.18 dehiscence commenced. At 7.25 very violent contortions. At 7.26 skin dropped off. There was a gradual darkening throughout the process: but at 7.32½ occurred a sudden

pallescence. At 7.34½ colour normal again. At 7.35 movement practically ceased. At 7.38 the subject had a 'granular' appearance. After movement had apparently ceased there was a violent twitch at 7.47½. At 7.50 there was some surface hardening apparent and joints were beginning to show; there was a shininess over posterior half. Another twitch at 7.57. Faint movement at head at 7.59. Faint movement of anterior half at 8.01. Slight elongation and swelling apparent during last ten minutes. Slight movement of head at 8.04. Sudden pallescence at 8.06½: 8.08 normal again. Concavity in dorsal ridge becoming apparent. From 8.08 to 8.09 head raised slightly: 8.09-8.10, lowered. No further movement or perceptible change by 8.15. But by 8.45 chrysalis had taken complete shape: length, 28 mm. At 9.30 p.m., no change, nor at subsequent visits.

15th June: No change up to 11.30 a.m., when I went out. There were a slight movement and elongation before I returned at 7.0 p.m., since I then found the anterior (pendulent) tip of the chrysalis hanging over the other side of a stem from that which it had been previously.

16th June: Obvious filling-out of pupa. Now paler. At 11.15 a.m. I cut away a leaf which was now caught up on anterior end. At 11.43 a.m. I noticed a slight movement of the chrysalis.

17th, 18th, 19th and 20th June: Nothing to report.

21st June: I cleared frass, cut away sprays which might impede hanging to dry wings, recovered last skin (including head), watered bush and measured pupa. Measurements were: length 30 mm., depth (ventral to dorsal surfaces at maximum) 13 mm., width lateral) 7 mm. I also made a sketch.

22nd, 23rd and 24th June: Normal.

25th June: Imago beginning to develop visibly within translucent pupa.

26th and 27th June: Envelope of pupa slightly more opaque, but slow development still visible within.

28th June: Faintest possible blue tinge beginning to appear on pendent dorsal portion of pupa, i.e., towards head.

29th June: Slow development within envelope.

30th June: Slow development within envelope. I sprayed chrysalis.

1st July: Development continued. Chrysalis beginning to assume papery texture, especially towards head and on dorsal surface.

2nd July: Normal growth of imago continued, very slowly.

3rd July: Sprayed chrysalis. It twice shook itself like a dog (2.40 p.m.). Development as before.

4th and 5th July: Development as before.

6th July: Growth of imago as before. I gave chrysalis half an hour in the sun with lid and cylinder off cage. I sprayed chrysalis. It shook itself as before four times (11.0 a.m.). Measurement of length of pupa 32 mm. Bush moved round to admit sun on all sides.

7th July: Growth of imago much accelerated (seen against light). Seen with light behind one, blue tinge now extending to nearly the whole of envelope of chrysalis. But traces existing of a brighter green on the side which had normally been away from the window.

8th July: 'Embryo' visible; with the appearance of being in three portions, all developing. In the evening main lateral joint becoming much emphasised. At 10.20 p.m. a faint movement of the head end of chrysalis.

9th July: Bluing much more pronounced and wider spread. Lateral line becoming increasingly emphasized. 'Embryo' darkening and becoming continuous. By 10.0 p.m. embryo filling entire envelope (when seen against light), except dorsal ridge: which latter was now strongly marked with dark indentations. A pulsing movement occasionally observable. Pupa last viewed just after midnight.

10th July: Saturday. At 6.15 a.m. I found the Emperor, a male, emerged. Wings already fully expanded, but still dull: insect hanging from side of pendent portion of chrysalis, head upwards. By 8.0 o'clock colour much brighter. At about 9.0 o'clock it crawled further up the empty chrysalis, still with head upwards. At about 12 noon turned upside down. At 2.30 p.m., still upside down, opened wings for a few moments during sunshine.

'Belfield',
Burnham-on-Sea,
Somerset.

11th November, 1954.

A NOTE ON THE DETERMINATION OF THE NYMPH OF AESHNA CAERULEA (STRÖM)

IT HAS been pointed out to me by Dr. Edmund M. Walker, of Ontario that the nymph of *Aeshna caerulea caerulea* (Strom) has only six segments to its antennae, and thus differs from the nymphs of all other British Aeshnas. This was first noticed by Dr. Erich Schmidt, of Bonn, and was later confirmed by Dr Walker. This character is shared by *A. caerulea septentrionalis* Burmeister and *A. sitchensis* Hagen, another boreal species of Canada and a more common form than *septentrionalis*. This character, although apparently trivial in nature, is of great importance in that it will at once serve to identify *caerulea* from all other Aeshnas found in these islands.

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A STUDY OF THE GENITALIA OF THE TWO SPECIES *SYMPETRUM NIGRESCENS* LUCAS AND *S. NIGRIFEMUR* (SELYS) WITH NOTES ON THEIR DISTRIBUTION. (ODONATA: LIBELLULIDAE)

By A. E. GARDNER, F.R.E.S.

Sympetrum nigrifemur (Selys) was first described as a race of *Diplax vulgata* by de Selys (1884) from 2 ♂♂ and 2 ♀♀ from Madeira. Of these specimens de Selys writes: 'I give this name to the examples that I have received from Madeira, and probably also those in the Canaries. The femora are blackish without yellow lines, and on the tibiae the yellow only occupies one narrow external streak. The dimensions are very big: abdomen male 27; female 26-29. Hindwing male 30-33; female 30-33. Pt. 2.3-4.3. Thus, this local variety recalls *frequens* of Japan, the suppression of the yellow stripe and the vulvar scale, which are like the type of *striolata.* Add also, that in the two couples from Madeira that I have examined, the black parts of the sides of the thorax are very dark, so much so, that the two yellow bands that they divide are strongly determined.'

Later de Selys (1887) described *nigrifemur* as a *form* of the common and widely distributed *Sympetrum striolatum striolatum* (Charp.) and briefly mentioned the genitalia. 'It is, without doubt, in accordance with the hamulus and valvula valvae *striolatum,* whereby the hamuli for the large form is still small.' Ris (1911) elevated it to the rank of a subspecies, this status being accepted by Bartenef (1919) who writes: 'Apparently this is a separate subspecies which, owing to its island distribution, is not directly connected either morphologically or geographically with *Sympetrum striolatum striolatum.* The hiatus between them is so small that there is no doubt that this form is a subspecies.' From this time odonatists appear to be agreed that the *Sympetrum* from Madeira, characterized by darker femora and strongly pronounced lateral thoracic markings, were merely a subspecies of *S.s.striolatum.*

Specimens smaller in size but closely resembling *nigrifemur* in coloration had by this time, been recorded from Scotland, Ireland and Norway. Of these insects, distinct differences of opinion were expressed as to their status. The first examples were two females taken by Mr. H. S. Fremlin at Stornoway in the Outer Hebrides, during 1889. These insects were sent to Lucas, who (1900) concluded that they belonged to a form of *Sympetrum striolatum* somewhat resembling *S. danae* (Sulz.) or that both dragonflies were hybrids between these two species. McLachlan who examined the specimens favoured the latter opinion. In 1911 Lucas received a pair of dragonflies taken by Col. Yerbury at Lochinver, Sutherland, which, in coloration, closely resembled the Stornoway females. Lucas (1912)

described them as a new species *Sympetrum nigrescens** and, although detecting slight differences in the male genitalia as compared with *S.s.striolatum,* no detailed examination was made, colour being the major character considered. Morton (1914) having examined a number of *Sympetrum* from Scotland, Ireland, Isle of Man and one from Christiansand, Norway, does not appear to accept *S. nigrescens* Lucas, and after taking into account the coloration of the specimens examined, came to the conclusion that the form described by Lucas extends with a certain amount of variation, both individual and local, over the whole western fringe of Scotland; while examples from Ireland, especially from the north and west, although more variable are in some respects intermediate, and more closely associated with the Scottish form than with the typical one.

Bartenef (*loc. cit.*) who did not have specimens of *nigrifemur* and *nigrescens* at his disposal, was reluctant to give an opinion as to the status of the two forms, or to accept the opinion of Ris (1919) that they were synonymous. Bartenef giving *nigrescens* subspecific rank, writes: 'The occurrence of the first endemic dragonfly in the north-west of Europe has to be noted, moreover it occurs on so small an area as the western shores of Scotland (northern and western Ireland), this is a rare fact for such fairly widely distributed forms of dragonflies. Secondly, the close relationship (perhaps even identity) of the Scottish form *nigrescens* with *nigrifemur* from Madeira Island, that is from the extreme south-west of the Palaearctic, and their absence in localities between these two places, is of interest; moreover the distance between the two habitat areas of the forms is thousands of times greater than their habitat areas. The question is still further complicated by the occurrence of two females in North America, Ohio; the females are similar in their colouring to these forms, resembling however, *Sympetrum scoticum* ‡ by the structure of their genital plate; I have described them in the present work under the name *Sympetrum verum.*† The close relationship of the Scottish and the Madeira forms of *Sympetrum striolatum,* is evident from the structure of their genitalia.

Hence I am drawing the following conclusions: (1) The European *nigrifemur* and *nigrescens* and the American *verum* are analogous in their colouring, but not identical: the first two are more closely related to *striolatum,* the last to *scoticum.* (2) The analogy between the Scottish, Madeira and American forms, even without concerning ourselves with relating them to *striolatum* and *scoticum,* gives certain grounds for regarding these two latter forms as relatives. . . . I regard the forms *nigrifemur, nigrescens* and *verum* as relics of the

* Lucas (1929) appears to have abandoned his claim that *nigrescens* was a good species, saying that the *race* name of *nigrescens* had been bestowed upon it.

‡ *S. danae* (*Sulz.*) = *S. scoticum* (Donovan).

† Not accepted as a good species, very propably *S. danae,* but no material available.

ice age, preserved in two extreme points: western Europe, and the east; only this latter occurrence, which for dragonflies would be eastern Siberia, has been drawn further east to America.'

More recently, odonatists have considered *nigrescens* and *nigrifemur* as synonymous and to have applied the latter name for heavily marked specimens with dark femora as recorded from western Scotland, Isle of Man, Ireland and Norway. The opportunity to investigate this problem more closely did not arise until July, 1954, when fresh material became available for dissection.

On 1st July, Mr. L. Christie dredged five *Sympetrum* larvae from a small coastal pond at Skelbo, east Sutherland. The insects were kindly sent to me and duly enclosed imagines, 3 ♂♂ and 2 ♀♀, from 21st to 28th July, 1954. In coloration all five dragonflies were referable to Lucas's description of *nigrescens*. A dissection of the male accessory genitalia revealed a constant and striking difference in the shape of the hamuli as compared with those of *S.s.striolatum*. Differences from the latter species were also found with regard to the female genitalia and the mid-dorsal abdominal spines of the larvae. The Skelbo specimens were compared with the type ♂ and ♀ *nigrescens* in the Lucas Coll., and in structure and coloration they were identical. In response to my request, material was made available for study from widely separated localities which confirmed that in areas where *striolatum* and *nigrescens* overlap, there is intergrading of colour, but that they remain structurally distinct.

An examination of the *nigrifemur* material in the British Museum Coll., revealed that in coloration they closely resemble *nigrescens*, but that the hamuli of the male accessory genitalia is distinctive, showing a closer affinity to this latter species than with *S.s.striolatum* of which it had been considered a subspecies.

The confusion which previously prevailed regarding the status of these species has been entirely due to the fact that coloration had been used as the prior diagnostic character. A parallel case is to be found regarding the separation of *S. striolatum striolatum* and *S. vulgatum* (L.). Since these latter species are closely related to those under consideration, it is thought advisable to briefly relate the history of their separation.

Charpentier (1840) gave the first description of *Sympetrum s. striolatum* as a separate species, *Libellula striolata,* from Silesia. In the same work Charpentier describes another new species, *Libellula ruficollis* from Lusitania, later (Hagen, 1848) found to be identical with the first. Hagen (1840) described *Libellula sicula* from Sicily, this author (*loc. cit.*) later regarding it as a synonym of *S. striolata. Libellula macrocephala* from Sicily was described by de Selys (1841) later (Selys, 1850), to be regarded as a synonym of *striolata.* Thus from 1840 to 1841, three authors described *striolatum* as four different species. Shneider (1845) mentioning *Libellula striolata* from Phoenicia, writes: 'This species remains very doubtful, since it

differs from *L. vulgata* Charp., only by an unimportant and really often changeable characteristic, consisting of the development of the black colouring on the exterior of the sides of the tibiae and femora; in my opinion *L. striolata* Charp., and *L. vulgata* Selys. (sicula Hagen) are synonyms.'

Hagen (1840) and (1845) declared that Linné's type of *vulgata* was not the same species as Charpentier's *striolata.* They remained separated in 1850 (Selys, 1850) as they did in further lists in 1856, 1859, 1860 and 1871, where *L. striolata* is alone mentioned. Selys (1850) considered the question in some detail and came to the conclusion of the independence of the two species, first place being given again to the difference in the colouring and the problem was not solved. Meyer Dür (1874) tried to prove that *striolata* was not different from the species which Linné took for his *vulgata,* whilst Schoch (1880) considered *striolata* as a somewhat larger variation of *vulgata.* McLachlan (1881) listing *S. striolatum* as seen from Madeira (specimens in the B.M. Coll.) and very doubtfully from the Canaries, suspected they were *S. fonscolombei* (Selys) and says: 'Although I am using the name *striolatum* I think it is now generally believed that this species and Linné's *vulgata* are indistinguishable.'

The two species were joined as one species by de Selys (1884) as *Diplax vulgata,* with race. *striolata,* race. *nigrifemur* for the Madeira specimens, and race. *decolorata* for those from Armenia and Turkestan. The same author in this paper gives the opinion of Albarda, that, from a study of the genitalia, the two species are distinct, and writes: 'I have come to the conclusion that this opinion is correct, by observing numerous specimens; but the number of specimens from various countries still in need of observation is so great, that I fear to increase the confusion by trying to establish at present the region of the distribution of the two forms.' Finally de Selys (1887) separated *striolatum* and *vulgatum* on the basis of the structure of the genitalia. Later authors who joined the two species relied on coloration as the prior diagnostic character, but it seems clear that the separation of the two species was started on the right lines by Hagen and Albarda, being finally decided by de Selys (*loc. cit.*) when the classification was based on a study of the genitalia.

Sympetrum nigrescens Lucas, 1912.

Holotype ♂ and *allotype* ♀: Lochinver, Sutherland (♂, 24:6:1911; ♀, 7:7:1911), Col. T. W. Yerbury. In the Lucas collection, Hope Department of Entomology, Oxford.

Material identified (40 ♂♂, 9 ♀♀). SCOTLAND: *Sutherland*: Skelbo, Tongue, Scourie, Durness. *West Ross*: Talladale, Gairloch, Alligin. *Westerness*: Moidart. *Argyllshire*: River Awe, Loch Awe, Glen Morven, Morven, Loch Tromlee. *Outer Hebrides:* Isle of Barra, Stornoway (Isle of Lewis). *Inner Hebrides:* Isle of Islay. *North Ebudes:* Isle of Raasay, Isle of Eigg. *South Ebudes:* Isle of Colonsay.

IRELAND. *Co. Dublin*: Royal Canal, Pakenham Bridge. *Co. Cork*: *Garnish. *Co. Wicklow*: Murrogh of Wicklow.

ENGLAND. *Durham:* Newcastle.

NORWAY. *East Agder*: *Buskerud*: Modum. *Hordaland*: Fana.

Original description by Lucas (1912)

'*Description.*—Vertex ochreous; anterior to it a rather broad black band, extending to some extent downwards along the side of the eyes as in *S. vulgatum*. Rest of face ochreous, rhinarium and neighbourhood being rather lighter; hairs black. On the mesonotum two distinct narrow longitudinal yellowish streaks. Ground colour of sides of thorax nearly black, with two large bright yellow oblong spots; between these four small ones, and below them, three others, all bright yellow; under surface of thorax very dark, with bright yellowish markings. The thorax recalls very strongly that of *S. scoticum*. Wing-nervures black; pterostigma as in *S. striolatum*. Fore-legs black, with femur somewhat ochreous below; mid and hind-legs black; all legs with a fine ochreous line along the tibia. Abdomen blackish below; ridges outlined in black; two black dorsal dots on several of the segments. In the female there are, in addition, strong black lateral lines on the segments of the abdomen. Genitalia much as in *S. striolatum*. In the male the inter hamular branch perhaps a little more blunt and the external one a little sharper and more distinct. The margin of the vulvar scale nearly straight, barely hollowed. Size between that of normal *S. striolatum* and *S. scoticum*. General appearance so distinct from normal *S. striolatum* that one was relaxed, set, and put in the cabinet with *S. scoticum* before the difference was noticed in size and pterostigma.'

Having studied the type specimens, I would add the following: *Length* (in millimetres) ♂, Abdomen (inc. apps.) 27. Hindwing 26; ♀, Abdomen 26. Hindwing 27. Nodal index: ♂, $\frac{6\text{-}7 \mid 7\text{-}6}{7\text{-}5 \mid 5\text{-}7}$ ♀, $\frac{6\text{-}8 \mid 7\text{-}6}{7\text{-}5 \mid 6\text{-}7}$

In the material examined the average size of both males and females was found to be less than average *striolatum*. The following variation was noted in *nigrescens*: Length: ♂, abdomen (inc. apps.) 24-28; hindwing 25-29. ♀, abdomen (inc. apps.) 25-27.5; hindwing 25-30. The black line at the base of the frons is variable in width and the distance it extends down the margin of the eyes. It may be very narrow, represented only by a dark suffusion, or as in the Garnish

* The specimen in the Lucas Coll. is labelled 'Garmish, Kerry, 1928', and had apparently been taken by Philip P. Graves on 28th July. Lucas (1929) refers to this specimen, and the locality is again spelt 'Garmish'. Col. Niall MacNeill has informed me that the Ordnance Survey have no record of such a locality in Co. Kerry. MacNeill thinks that it is a not uncommon mistake to describe places on the Dursey Head promontory as Co. Kerry, though actually in Co. Cork. Here there are a headland, bay and village, all named Garnish'. Also in Co. Cork is the well-known island Garinish in Glengarriff Bay, but this is far removed from the Kerry border.

specimen, but little extended downwards. The thoracic lateral spots may vary in size, those on the metepisternum may be greatly reduced in size as in the Isle of Barra ♀ (Fig. 19) or absent, this correlated with a reduction of the black markings (Fig. 18) as in the Garnish and Colonsay ♂♂. The yellow line on the tibiae and extent of yellow on the femora are also subject to variation, generally, however the legs are much darker than in *striolatum*. Specimens which were taken late in the season bore traces of red coloration on the abdomen, in this respect they no doubt resemble the latter species. In localities where both *striolatum* and *nigrescens* occur, intergrading of coloration is indicated. This was most noticeable in specimens examined from east and south-west Ireland. In such examples the ♂ genitalia proved clearly diagnostic.

♂ *Accessory genitalia*

Penis:—Material examined: Skelbo 3 ♂♂; Tongue 1 ♂. Penis constant in character, relatively larger than in *striolatum*. but lacking any strong diagnostic feature. The most noticeable difference from *striolatum* (Fig. 1) is the more upward angle of the lateral lobes, the latter being shorter and with outer margin not angled (Fig. 2). Variation in the number of setae on the penis vesicle is not considered a reliable character. *Hamules:—Material examined:* 40 ♂♂. The hamules provide the most striking and easily determined separation character. Comparison and separation from *striolatum* and other closely related species can be made out with the aid of a hand lens, if any doubt exists, however, it is advisable to slightly relax the insect and to carefully remove a complete hamule by gently cutting away the base of the hamule from its attachment. When viewed in true lateral aspect, the inner and outer branches in *nigrescens* (Fig. 13) will be seen to be more widely separated from each other than those of *striolatum* (Fig. 12). The outer branch in *nigrescens* is also more angular and apically depressed, this best seen when the complete hamule is rotated to bring the outer branch in line with the inner, the latter being in a true vertical position. Compare *nigrescens* (Fig. 6) with *striolatum* (Fig. 4). Note also that in *nigrescens* the basal portion is more elongate than that of *striolatum* (Figs. 12, 13). The hamules of *S. vulgatum* (L.) (Fig. 15) are to some extent intermediate between *striolatum* and *nigrescens*, perhaps a little more closely related to the latter species. The relatively shorter hamules of *vulgatum* will separate it from both the foregoing species.

Female genitalia:—Material examined: 19 ♀♀.

The valvula vulvae when viewed from the side (Fig. 10) is shorter, more angled and with the apical rim more pronounced than in *striolatum* (Fig. 9). In the type ♀ a single seta was prominent near the apical margin, but was not apparent, nor could the seating be determined, on the majority of specimens examined. The apical concavity, like that of *striolatum* is variable in depth. Care should be taken when examining teneral material, as in *striolatum* the more

basal portion of the valvula vulvae tends to collapse, thus presenting a lateral outline not unlike that of *nigrescens*.

Egg.

Dried, but well preserved eggs adhering to the valvula vulvae of two specimens showed that the ovoid eggs closely resemble those of *striolatum* (Gardner, 1950).

Mature larva. (Fig. 20).

Material examined: 3 ♂♂, 2 ♀♀. Skelbo, Sutherland.

Colour

General coloration greenish-brown, legs lighter with an apical dark band on all femora. Abdomen with dark marblings and light spots towards the lateral margins. A more detailed description of the coloration is given under the separate headings.

Length

Excluding the antennae but including the anal appendages, 16.5 to 17.5 mm. Greatest width 7 mm., which occurs at the suture of the 6th and 7th abdominal segments.

Antennae

Slender, set 1.33 mm., apart, consisting of 7 segments of which the 1st (basal) segment of the flagellum is the longest. Total length 2.22 mm. *Toruli:* Conspicuous, pale in colour. *Scape:* Length 0.15 mm., dark apically. *Pedicel:* Length 0.31 mm., somewhat barrel-shaped. *Flagellum:* Slender, pale in colour, the apical and two preceding segments dark apically. Length: 1st (basal) 0.50; 2nd, 0.23; 3rd, 0.31; 4th, 0.44; 5th, 0.28 mm. All segments bearing scattered trichiae in addition to the apical crowns.

Eyes

Of medium size, anterior margin slightly flattened, lateral margin hemispherical; prolongations dark in colour, directed slightly caudad.

Ocelli

Median and lateral ocelli indicated by pale areas.

Head

Transverse in outline, width over eyes 4.8 to 5.2 mm.; length including the forward projection of the labium 2.7 to 2.9 mm. Occiput with the lateral margin of the postocular lobes convex, hind margin slightly concave; dorsal surface bearing scattered setae, these of greatest length on the lateral border of the postocular lobes. Attachments of the gnathal muscles indicated by pale and immaculate areas. Vertex raised.

Labium (Fig. 21)

Outline and armature closely resembling that of *striolatum* (Corbet, 1951). Labial palpi with less setae on the distal border, pigment spots darker and more numerous than in the latter species; these characters, like the major armature are, no doubt, variable and cannot be considered diagnostic. Length of labium 4.90 mm., reaching to the insertion of the mid-legs; width 3.70, when flattened 4.45 mm. Premental setae 15+16 to 16+16; palpal setae numbering 11.

Cervix

Collar-like, a dark transverse suffusion extending on each side of the pale median line.

Prothorax

Collar-like, length 1.29 mm., width 2.96 mm. Pale mid-dorsal line flanked by a transverse dark suffusion; hind border rim-like, bearing a tuft of hair-like setae on the lateral margin. *Mesostigmata* prominent, dark in colour.

Pterothorax

Length 2.96 mm., greatest width 4.80 mm., which occurs posteriorly. A lateral irregular, longitudinal pale line anterior to the pale metastigma.

Wing-sheaths

Length 5.55 to 5.92 mm., held parallel, hind overlapping the fore, reaching to the base of the 6th abdominal segment.

Legs

Long and slender, pale greenish-brown, all femora marked with a darker apical band. Length of the leg parts in millimetres:

	Femora	*Tibiae*	*Tarsi*	*Claws*	*Totals*
Fore	2.96	3.33	1.48	0.40	8.72
Mid	3.70	4.07	1.66	0.45	10.62
Hind	4.81	6.11	2.59	0.74	15.17

The coxae and trochanters add approximately 1.00 m.m. to the extreme reach of the legs when fully extended.

The tarsi may be further tabulated as follows:

	Basal segment	*Middle*	*Apical*	*Totals*
Fore	0.26	0.48	0.74	1.48
Mid	0.27	0.49	0.90	1.66
Hind	0.38	0.92	1.29	2.59

Chaetotaxy: Femora armed with piliform setae of moderate length on the anterior and posterior margins. Tibiae with long piliform setae on the posterior margin, these of greatest length at the middle of the limb; anterior margin of mid and hind-legs with fewer, and shorter setae than those of the fore-legs; tibial combs consisting of tridendate setae. Tarsi with the ventral surface armed with two marginal rows of short setae. The posterior row of all tarsal segments consisting of spinate setae, anterior row consisting of tridendate setae. These are not entirely consistent since it was found that in one specimen the anterior row of the middle segment of the mid-tarsi had more spinate than tridentate setae present.

Abdomen

Egg-shaped, strongly arched dorsally, ventral surface convex. Length (excluding anal appendages) 7.78 to 9.25 mm.; greatest width 6.85 to 7.03 mm., which occurs at the suture of the 6th and 7th segments. Colour greenish-brown, segments 1 to 8 with a dark basal suffusion on the lateral margins, this tapering to a light spot. Pale lateral spots on 1 to 8, these flanked inwardly by a dark crescent-

shaped suffusion also indicated on 9. Segment 10 short, unicolorous. Dorsal puncta evident but not conspicuous. Ventral surface pale, ventral puncta dark, conspicuous. Transverse carinae pale, anterior border armed with closely set, short spiniform setae. Lateral spines on 8 and 9; those on 8 straight, extending one-third over 9; those on 9 only slightly incurved, reaching to mid-length of anal appendages. Generally the lateral spines of *striolatum* are more strongly incurved than in this species, the most striking diagnostic character, however, occurs in connection with the mid-dorsal spines. These are situated on segments 4 to 8 and when viewed in lateral aspect appear straight (Fig. 22), as compared with the recurved spines of *striolatum* (Fig. 23). Although the latter species has rarely a spine on 4, in the material examined in which a vestigial spine was evident, it was never so conspicuous as that of *nigrescens*. The spine on 4 does not extend to the base of 5; that on 5 reaching to the base of 6; that on 6 to just over 7; that on 7 and 8 to about one-fourth or fifth over the succeeding tergite.

Anal appendages

Epiproct: Length 1.49 mm.; width 0.92 mm., at base, tapering to a slender point. *Male projection:* Length 0.78 mm., apically obtuse. *Cerci:* Length 0.60 to 0.74 mm., slender. *Paraprocts:* Length 1.48 mm., slightly incurved. Epiproct and paraprocts armed with lateral setae of medium length.

From the material examined it appears that by virtue of the shape of the lateral, and number and shape of mid-dorsal spines, the larva of *nigrescens* more closely resembles *vulgatum* than that of *striolatum*. It would have been desirous to have examined more material from widely separated localities, but since the five larvae in my possession appear to be the only specimens available, I tentatively amend my key to the larvae of the British Odonata (Gardner, 1954) as follows:

Page 198, line 44.

3 Abdomen with mid-dorsal spines on segments 3 to 8, that on 3 small. Labium with premental setae 14+14 to 15+15; labial palpi with 10 to 12 setae (usually 11), L. 17-18 mm. ..... **S. vulgatum** (L.). *A rare immigrant. Would breed in similar habitats to S. striolatum (Charp.). The larva has not been found in Britain.*

– Abdomen without a mid-dorsal spine on segment 3 ..... 4.

4 Abdomen with almost straight mid-dorsal spines on segments 4-8. Lateral spines straight or only slightly incurved. Labium with premental setae 15+16 to 16+16; labial palpi with 11 setae. L. 16.5-17.5 mm. ..... **S. nigrescens** Lucas. *Appears to favour waters close to, or not far removed from the coast. Generally of a more northern distribution than the succeeding species.*

– Abdomen with mid-dorsal spines on segments 5 to 8 (rarely a vestigial one on 4) ..... 4a.

4a Abdomen with recurved mid-dorsal spines on segments 4-8 (rarely a vestigial one on 4). Lateral spines generally incurved. Head viewed dorsally as (Fig. 109); viewed from in front as (Fig. 111). (Larvae approaching metamorphosis with head pattern (Fig. 109) having 'bulges' posterior to the lateral branches of the epicranial suture with a linear posterior margin). Labium with premental setae 14+14

to 15+15 (more rarely 13 to 18); labial palpi with 11 to 12 setae. L. 15.5-18 mm. ..... **S. striolatum striolatum** (Charpentier). *Breeds in ponds, lakes and canals.*

Time of appearance

The earliest record is of a teneral female kindly sent me by Dr. I. D. Pennie, this was taken during the first week in June, at Scourie, Sutherland. The latest record is a male taken on 15th September, River Awe, Argyllshire, by Morton. Probably it is most numerous during July and August.

Geographical distribution

Until more material is available it is not possible to accurately define the distribution. From the material available it is notable that *nigrescens* appears to favour coastal habitats or those not far removed from the coast (Fig. 26). Thus, from the south and south-west coast of Norway, it occurs on the north coast of Scotland, extending a little to the north-east and well down the west coast, where also it occurs on many of the islands. In Ireland specimens have been examined from the east and south-west coast. In England the single ♂ examined from Durham is considered to be an immigrant, probably of Norwegian origin.

Nigrescens should be looked for on the Isle of Man and on the north coast of Wales. Of the Isle of Man *Sympetrum*, Allen and Cowin (1954) state that 'The dragonfly *Sympetrum striolatum* (Charp.) is predominantly represented by the form *nigrifemur* (Selys)*, but while intermediates tending towards typical *striolatum* are frequently met with, as in Wales, the typical form has only been encountered on a single occasion.†' Specimens of *S.s. striolatum* in my own collection taken by Dr. P. S. Corbet from the 'Curraghs', large areas of marshy ground near Sulby in the northern part of the Island, although all darker in colour than the more southern form, all showed the typical *striolatum* genitalia.

In literature frequent reference is made to intermediates, but since these are not accurately defined it is assumed that intermediate coloration is implied. Beirne (1952) states that there is evidence of interbreeding between the older Celtic Land and more recent invaders. This author cites intermediates between *striolatum* and *nigrifemur* in parts of Wales. Although not an impossibility, the highly specialized structure of the male accessory genitalia is most likely to prevent the successful pairing of even closely related species. The specimens to which Beirne refers are most likely to be the darker form of *striolatum*.

Sympetrum nigrifemur (Selys), 1884.

Diplax vulgata race *nigrifemur* Selys, 1884

Sympetrum striolatum race *nigrifemur* Selys, 1887

Described from 2 ♂♂, and 2 ♀♀ from Madeira. A translation of

* Used in the sense that *nigrescens* and *nigrifemur* are synonymous.

† Dr. Cowin has kindly informed me that the material in the Manx Museum is no longer available for study owing to damage.

de Selys' original description is given at the commencement of this paper.

Material identified (6 ♂♂, 2 ♀♀). *Madeira:* 1 ♂, Funchal, McLachlan Coll.: 3 ♂♂, 2 ♀♀, T. V. Woolaston 1858: 2 ♂♂, Shackleton-Rowett Expedition, (1,500 and 2,000 ft.) 1921. All in the British Museum Collection.

S. nigrifemur is a larger insect than *nigrescens*, the full variation in size found in the material examined being: Length: ♂, abdomen (inc. apps.) 27-30; hindwing 29-33 mm. ♀, abdomen (inc. apps.) 26-29; hindwing 30-33 mm. In colour it closely resembles *nigrescens* with similar variation in extent of the black line at the base of the frons, and thoracic lateral markings. Although the type specimens are described as having all black femora, in the material examined, several specimens exhibited a very narrow yellow line on the outer, and a broader line on the inner margin.

♂ Accessory genitalia

Apart from one malformed specimen, the hamules proved diagnostic and constant in character. When viewed in true lateral aspect it will be seen (Fig. 14) that the inner and outer branch are directed more widely apart than those of *striolatum* (Fig. 12), that the inner branch is less inwardly curved, and notably more basally constricted than in *nigrescens* (Fig. 13) and *vulgatum* (Fig. 15). The outer branch is spade-shaped and when rotated so as to become in line with the inner branch (Fig. 8) it bears more resemblance to that of *striolatum* (Fig. 4), being less apically depressed than that of *nigrescens*.

Female genitalia

The valvula vulvae when viewed from the side (Fig. 11) is more robust and less angular than those of the nearly related species. In ventral aspect the apical concavity exhibits variation and is not diagnostic.

Egg and larva

Unknown.

Time of appearance

The Shackleton-Rowett ♂♂ were taken on 17th October, a Woolaston ♀ on 23rd December; it is probably on the wing at a much earlier date.

Distribution

The Island of Madeira. Although reputed to occur on the Canary Islands this record has not been substantiated.

Sympetrum striolatum striolatum (Charpentier), 1840.

Material examined (48 ♂♂, 27 ♀♀) ENGLAND. *Cheshire:* Meols, Thurston. *Cornwall:* Goss Moor. *Derbyshire:* Hilton gravel pits. *Durham:* Newcastle. *Essex:* Epping. *Hampshire:* Totland and Freshwater (Isle of Wight). *Huntingdonshire:* Wood Walton Fen. *Isle of Man:* Curraghs, near Sulby. *Lincolnshire:* Epworth

Turbary. *Middlesex:* Stanwell Moor. *Surrey:* Bookham, Byfleet Canal, Egham, Esher, Epsom, Ockham, Wisley. *Sussex:* Bexhill, Bracklesham Bay. WALES. *Cardiganshire:* Tregaron Bog. *Carnarvonshire:* Abersoch. *Radnorshire:* Boughrood. IRELAND. *Co. Cavan:* Pole Hill. *Co. Dublin:* Ashtown, Royal Canal, Pakenham Bridge. *Co. Kerry:* Killarney, Parknasilla. *Co. Mayo:* Clougher, near Westport. *Wexford:* Wexford.

SPAIN: Albarracin, Pyrénées Orientales. CZECHOSLOVAKIA: Rabka, West Carpathians. SWITZERLAND: Uetliberg.

Sympetrum s. striolatum has a wide distribution and in Europe is principally a Mediterranean species. Its range extends from Spain and Portugal, to South Russia. In the south it reaches North Africa and extends eastwards to Asia Minor, Palestine, Iran and as far east as Kashmir. The subspecies *S.s.pallidum Selys* is reputed to be peculiar to the transition zone of the Palaearctic region, whilst *S.s.imitoides* Bartenef occurs in China and Japan. These subspecies are very lightly coloured, the latter with a diffused yellowish line extending along the costal margin of the wing. No material was available for examination and it may be found that a close study of the genitalia will produce interesting results. To the north *S.s.striolatum* extends to south Sweden and Norway, the most northern locality being Nord-Trondelag (Somme, 1937).

In the British material examined the following variation in size was noted: Abdomen (inc. apps.): ♂, 25-30; hindwing 25-30. ♀, abdomen (inc. apps.) 26-29; hindwing 26-30 mm. Although variation in size was found in both northern and southern examples, the latter were generally larger and more robust insects. Average: ♂, abdomen 29; hindwing 29. ♀, abdomen 28; hindwing 29 mm.

The coloration may vary as follows: The black line at the base of the frons is generally described as not extending down the side of the eyes, in several specimens from more northern localities, however, it was found to extend downwards for a short distance, or to be represented by a dark suffusion. On no insect, however, was it so pronounced as in *vulgatum* or the majority of *nigrescens*. The black coloration on the legs was found to be of greater extent on specimens from the north and west. A wide range of variation exists with regard to the thoracic lateral markings, the lateral sutures may be but lightly or heavily marked with black; the yellow spots on the mesinfraepisternum divided or confluent; that on the mesepimeron divided from those on the metinfraepisternum, or narrowly connected. The metepisternum may be lightly coloured, darkly suffused, or with a posterior spot as in northern and western examples, never, however divided into an anterior and posterior spot as in typical *nigrescens*. The latter variation of *striolatum* is a colour intergrade with the more southern examples of *nigrescens*.

Separation should be made by the examination of the genitalia, this being discussed in the chapters dealing with the latter species.

Mature larva

Material examined: 25 exuviae and 5 spirit preserved specimens from the following localities: ENGLAND. *Surrey:* Epsom, Ockham, Wisley. *Sussex:* Bexhill. *Middlesex:* Stanwell Moor. Bred specimens from an Isle of Man female. IRELAND. *Co. Dublin:* Ashtown, Royal Canal, Pakenham Bridge. *Kerry:* Caragh Lake.

Sympetrum vulgatum vulgatum (L.) 1758.

Material examined: (4 ♂♂) FRANCE: Augbiny-au-Bac. HOLLAND: Laende, near Eindhoven. *Larvae:* 1 specimen Augbiny-au-Bac, 7 specimens Siegburgh, near Bonn, Germany.

In the British Isles *S. vulgatum* is a rare immigrant, it has been recorded from Yorkshire, Middlesex, Essex, Devon, Surrey and Kent. Abroad it is found in north-west and central Europe, from north Scandinavia and Lapland, south-east across Russia to China, and from the Channel Islands and northern France via the Alps and Balkans to the Caucasus. It has been recorded from Kashmir (Longfield, 1949). Two decolourized subspecies have been described, *S. vulgatum rossicum* Bartenef and *S. vulgatum flavum* Bartenef, the latter widely distributed in the south-east of the Palaearctic region.

This species is notable for the black line at the base of the frons extending down the side of the eyes. Structural separation characters are given in the key to imagines and larvae.

Key to Sympetrum nigrescens, S. nigrifemur, S. vulgatum and *S. danae.*

Males.

1 Hamules of accessory genitalia with outer branch as long as, or longer than inner. Legs with femora, tibiae and tarsi all black. Pterostigma 3 times (or less) as long as wide (Fig. 24). ... **Sympetrum danae** (Sulzer).

– Hamules of accessory genitalia with outer branch shorter than inner. Legs with femora black, or as tibiae with yellow lines of varying width. Pterostigma 4 times (or more) as long as wide (Fig. 25). ... 2.

2 Hamules of accessory genitalia with inner and outer branches not widely separated (inner margins nearly parallel; outer branch not markedly depressed apically. **S. striolatum striolatum** (Charpentier).

– Hamules of accessory genitalia with inner and outer branches widely separated (inner margins strongly divergent). ..... 3.

3 Hamules of accessory genitalia with inner branch nearly straight, basally constricted; outer branch spade-shaped, not notably apically depressed. (Confined to the Island of Madeira.) **S. nigrifemur** (Selys).

– Hamules of accessory genitalia with inner branch not straight, not basally constricted; outer branch not spade-shaped. Basal portion of hamules short, nearly as wide as long (hamules notably short in comparison with the other species) ..... **S. vulgatum** (L.).

– Basal portion of hamules long, less than half as wide as long; outer branch strongly depressed apically ..... **S. nigrescens** Lucas.

Females.

1 Legs with femora, tibiae and tarsi all black. Pterostigma 3 times (or less) as long as wide. (Fig. 24.) ..... **S. danae** (Sulzer).

– Legs with femora black, or as tibiae with yellow lines of varying width. Pterostigma 4 times (or more) as long as wide. (Fig. 25.) ..... 2.
2 Valvula vulvae with apical margin not concave; projecting abruptly (almost at right-angles to abdomen) and in lateral view not visibly extending above the 9th segment. ..... **S. vulgatum** (L.).
– Valvula vulvae with a concavity of varying width and depth on apical margin ..... 3.
3 Valvula vulvae short, projecting abruptly, in lateral view with visible portion not extending above 9th segment, apical margin rim-like ..... **S. nigrescens** Lucas.
– Valvula vulvae moderately long, not projecting so abruptly, in lateral view with visible portion extending above 9th segment, apical margin not notably rim-like ..... **S. striolatum striolatum** (Charpentier).
– Valvula vulvae long, in lateral view extending less abruptly and extending well beyond 9th segment. (Confined to the Island of Madeira.) **S. nigrifemur** (Selys).

S. danae has been included in the above key as females and teneral males resemble *S. nigrescens* in coloration. They would occur in similar habitats in the north and west, and have been incorrectly determined in collections examined.

Summary

Sympetrum nigrifemur (Selys) is elevated to specific rank and *S. nigrescens* Lucas recognized as a good species on genital characters. The ♂ and ♀ genitalia are figured and described. The larva of *S. nigrescens* is figured and described. Imaginal colour variation is figured and described, notes on distribution and a map of the known British distribution of *S. nigrescens* is provided. The genitalia of *S.s.striolatum* (Charp.) and *S. vulgatum* (L.) are figured and described for comparative purposes, the colour variation and distribution of these species is discussed. Keys are provided for imagines and larvae. The history of the separation of *S.s.striolatum* from *S. vulgatum* is briefly given.

Acknowledgements

I am greatly indebted to Miss C. Longfield for reading the manuscript, for the loan of specimens and great assistance with literature and translations. I wish also to express my appreciation to the following Institutions for placing their material at my disposal and for the generous assistance which I have received: The British Museum (Natural History); The Hope Department of Entomology, Oxford; The Royal Scottish Museum, Edinburgh; The Zoology Department, University of Glasgow; City of Liverpool Public Museums; Zoological Museum, University of Bergen. For the generous gift of specimens I am indebted to Messrs. L. Christie, Dr. P. S. Corbet, E. W. Classey, W. K. Ford, Miss C. Longfield, Col. Niall MacNeill, Dr. I. D. Pennie, Dr. E. Schmidt, F. T. Vallins, Dr. A. R. Waterston and R. Weal. Dr. W. S. Cowin, Dr. A. Tjonneland and Col. Niall MacNeill kindly provided me with desired information.

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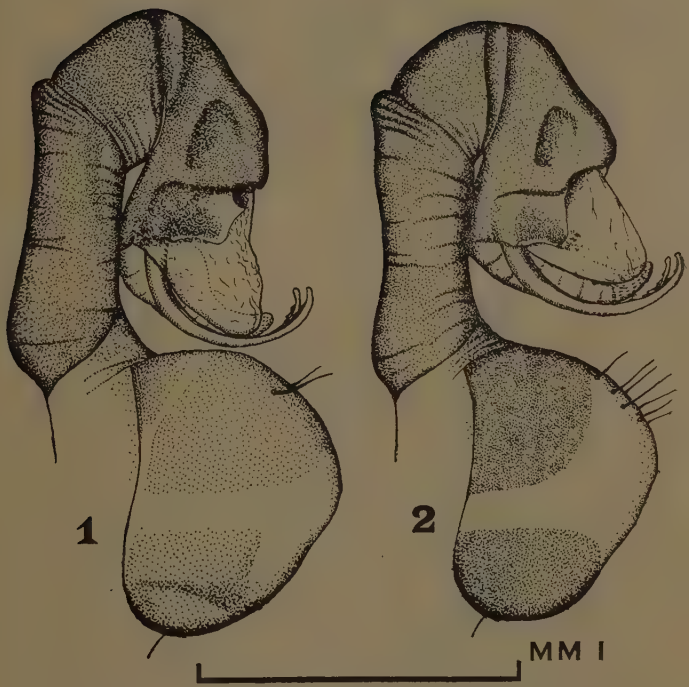
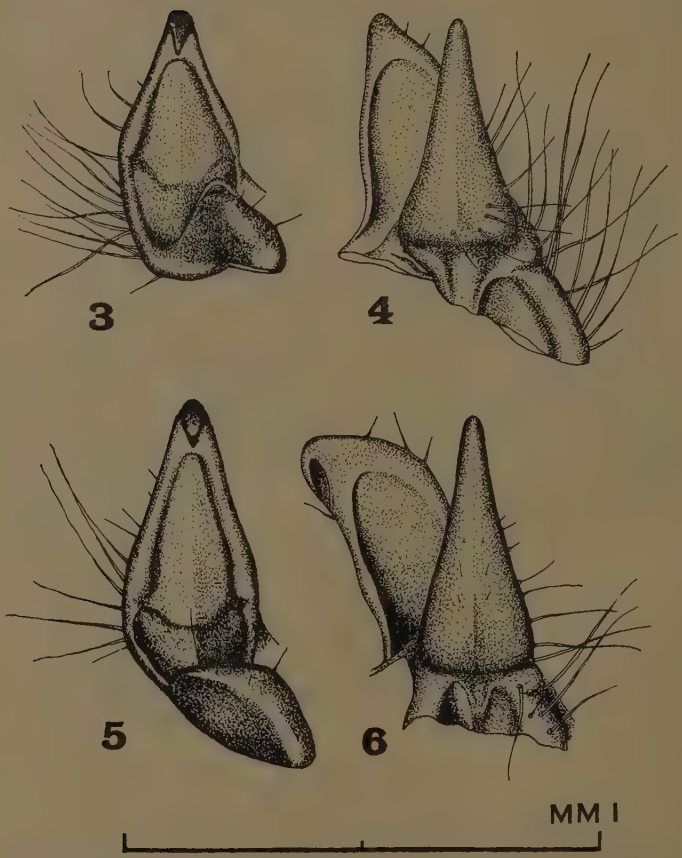


Fig. 1. Penis of *Sympetrum striolatum striolatum* (Charp.).
Fig. 2. Ditto. *Sympetrum nigrescens* Lucas.



Left hamule of ♂ accessory genitalia; Fig. 3. *Sympetrum s. striolatum* (Charp.), ventral view. 5. *S. nigrescens* Lucas, ventral view. 4. *S. s. striolatum*, anterior view. 6. *S. nigrescens*, anterior view.

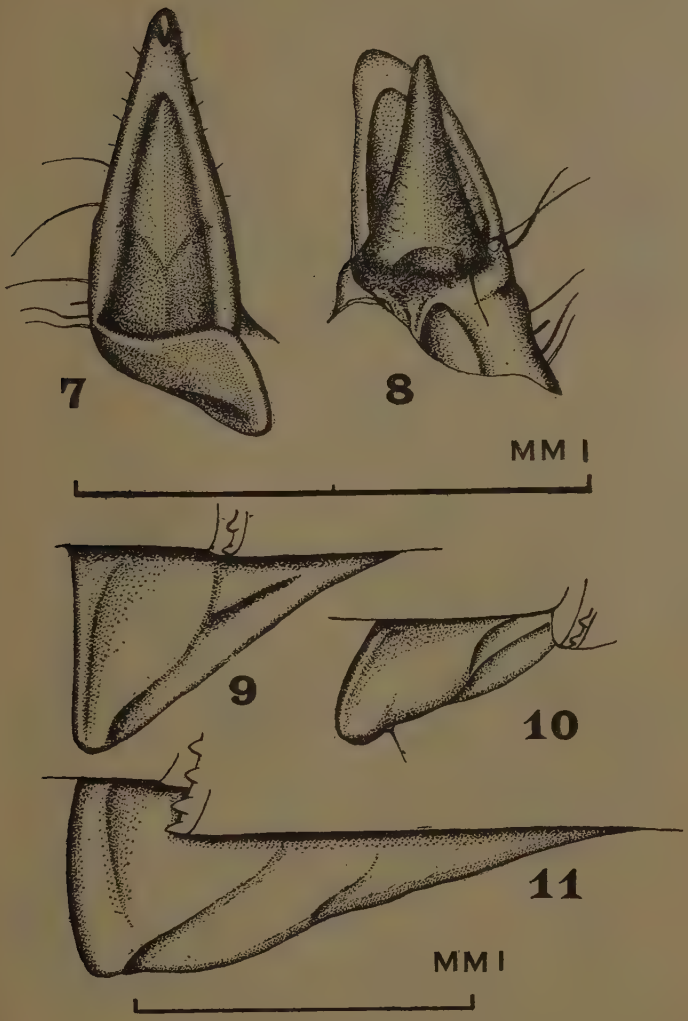
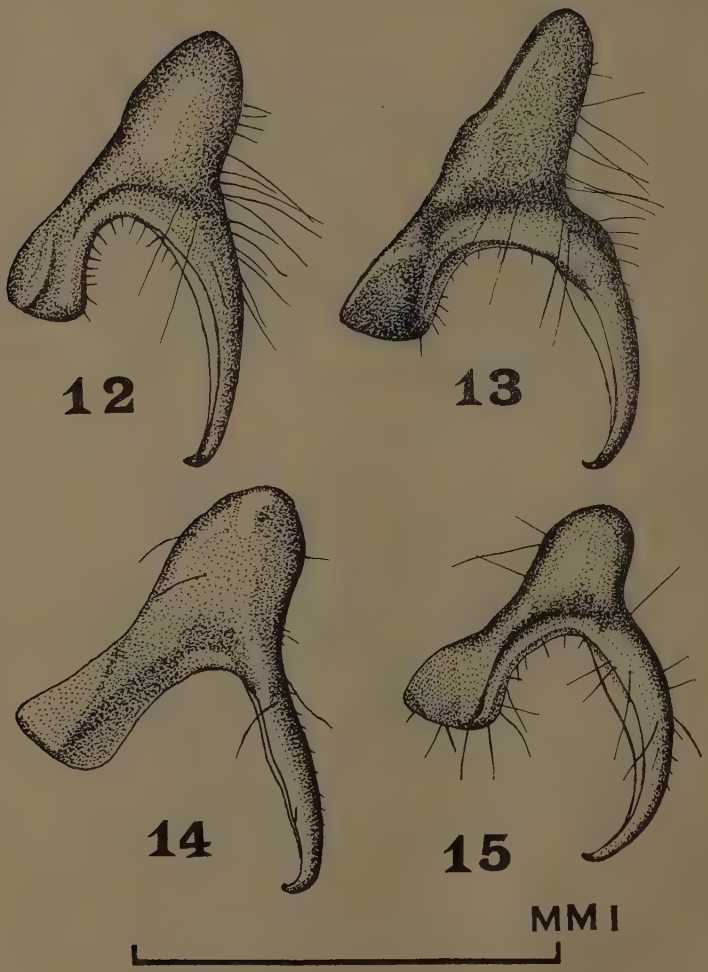
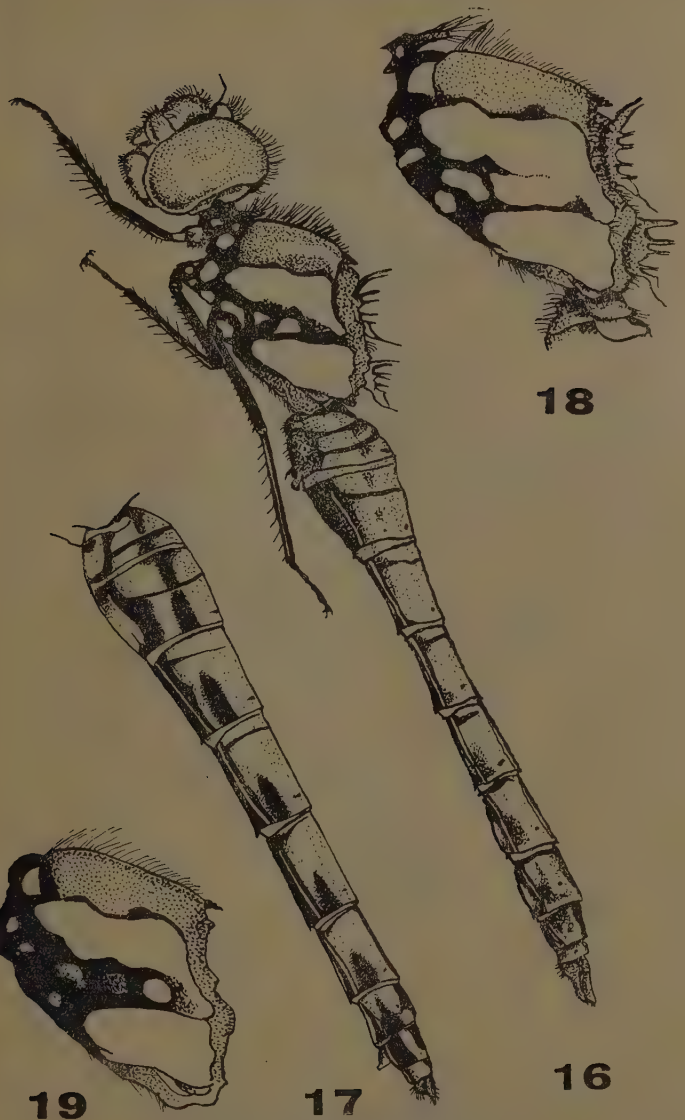


Fig. 7. Left hamule of ♂ *Sympetrum nigrifemur* (Selys), ventral view. Fig. 8. Anterior view. Lateral view of ♀ valvula vulvae: Fig. 9. *S.s. striolatum* (Charp.). 10. *S. nigrescens* Lucas. 11. *S. nigrifemur.*



Left hamules of ♂ accessory genitalia. Lateral view.
Fig. 12. *Sympetrum s.striolatum* (Charp.). 13. *S. nigrescens* Lucas. 14. *S. nigrifemur* (Selys). 15. *S. vulgatum* (L.).



SYMPETRUM NIGRESCENS Lucas.

Fig. 16. Lateral view of typical ♂. 17. Abdomen ♀. 18. Thoracic markings of Garnish (Ireland) ♂. 19. Thoracic markings of Isle of Barra (Scotland) ♀.

SYMPETRUM NIGRESCENS Lucas.
Fig. 20. Mature larva ♂.

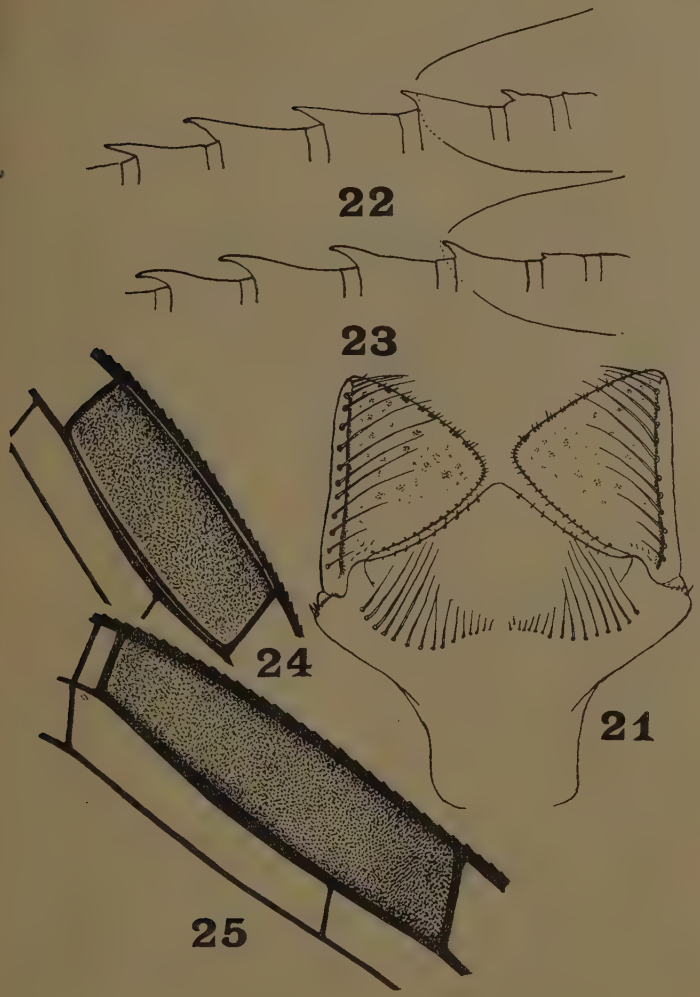


Fig. 21. Labium of *Sympetrum nigrescens* Lucas. Lateral view of mid-dorsal abdominal spines. 22. *S. nigrescens*. 23. *S. s. striolatum* (Charp.). Pterostigma of left fore-wing. 24. *S. danae* (Sulz.). 25. *S. nigrescens*.

Fig. 26. Known distribution of *Sympetrum nigrescens* Lucas in the British Isles.

SOME RECORDS OF ACRIDIDAE (ORTHOPTERA) FROM THE MSS. OF THE LATE E. J. CLARK

By R. S. George, F.R.E.S.

In a posthumously published paper by the late E. J. Clark (1948), eight species of grasshoppers, all Acridids, were discussed, the results coming from field work done 'mostly in Surrey (North Downs area), Berkshire and Oxfordshire (Oxford district), with some records from Buckinghamshire, Gloucestershire and Monmouthshire.' Following from this Kevan (1952) tentatively presumed the presence of several of these species in those vice-counties covered by Clark's remarks and for which there were no other published records. In the course of checking Gloucestershire records I obtained the very kind permission of Professor G. C. Varley to borrow Clark's MSS. and note

TABLE I

VICE-COUNTY Name.	No.	*St. lineatus*	*Om. ventralis*	*Om. viridulus*	*Ch. brunneus*	*Ch. albomarginatus*	*Ch. parallelus*	*Myrm. maculatus*	*Gomph. rufus*
Surrey	17	X	+	X	X	+	X	X	X
Berkshire	22	+	+	X	X	X	X	X	+
Oxfordshire	23	+[1]	O	X[1]	X	X	X	X	+
Buckinghamshire	24	§	X	X	X	X	X	+	§
Gloucestershire East	33	+	+	+[1]	X[1]	§	X	+	+
Gloucestershire West	34	+	+	X[1]	X	§	X	X	X
Monmouthshire	35	§	§	§	+	§	X	X	§

\+ indicates that a published record for the v.-c. existed prior to Clark's (1948) paper, although the MSS. do not indicate his having found the species in question.
X as last but recorded in Clark's MSS.
O indicates presumption by Kevan (1952), confirmed by Clark's MSS., i.e., a v.-c. record.
§ indicates presence in v.-c. not confirmed.
[1] Kevan's (1952) Summary states that records for these species from these vice counties can only be assumed from Clark (1948). This was due to a *lapsus calami* and to an oversight; published records were in fact known (Kevan, *in litt.* 1954).

books, which are now the property of the Hope Department of Entomology, University Museum, Oxford, and also his authority to publish the records extracted therefrom. In view of the value of Clark's (1948) contribution to grasshopper ecology, it is considered that records of the localities in which he made his observations would be of interest, especially since some of these affect the known vice-comital distribution of certain species. As indicated in Table I nine vice-county records provisionally accepted by Kevan cannot in fact be substantiated. Details are given in the list of locality records which comprises the bulk of this paper.

Clark's notes are in two main sections, representing work done in 1941 and 1944. During 1941 he frequently used the colour-form names of Vorontzovskii (1928; *c.f.* also Rubtzov, 1935), but in 1944 he extensively, but not invariably, used his own notation system (Clark, 1943). Little reference to colour variations will be made for the present, however, although it may be possible to make some observations on these at a later date.

My most sincere thanks are due to Professor G. C. Varley for making the Clark MSS. available to me, to Mr. D. K. McE. Kevan for his very helpful advice, and to the County Archivists and County Surveyors of Berkshire, Buckinghamshire, Monmouthshire, Oxfordshire and Surrey for helping me to establish the position of certain localities about which I was uncertain.

LIST OF E. J. CLARK'S LOCALITY RECORDS

Stenobothrus lineatus (Panz.). SURREY: Effingham, roadside field, 16.viii.44; Banstead Heath, 16/18.viii.44; Banstead Down, 13.viii.44; Box Hill, 14.viii.44; Chipstead, 1/3.x.41; White Downs, 20.viii.44; Colley Hill, 22.viii.41, 22/24.ix.41, 1.x.41, 8/9/15/17.viii.44; Sheepleas, 17.viii.44.

Omocestus ventralis (Zett.). OXFORDSHIRE: Merton, 3.viii.44. BUCKINGHAMSHIRE: Oakley, track, 2.viii.44.

Omocestus viridulus (L.). SURREY: Kingswood, 13/18.viii.44; Burgh Heath, 12/13.viii.44; Banstead Down, 13.viii.44; Banstead Heath, 16/18.viii.44; Chipstead, 3.x.41; Effingham, roadside field, 16.viii.44; Box Hill, 18.ix.41; Leith Hill, 20.viii.44; Epsom Common, 25.viii.44; Colley Hill, 24.ix.41, 8.viii.44. BERKSHIRE: Wytham, roadside, 22.vii.44; Wytham, field, 27.viii.44; White Horse Hill, cross-roads, 3.ix.44; White Horse Hill, moat slopes, 3.ix.44; Appleton Lower Common, 31.vii.44, 1.ix.44; Bow's Hill (now known as Boar's Hill), 18.ix.41, 5.ix.44. OXFORDSHIRE: Shirburn Hill, 23.vii.44; Waltington Hill, north-west slope, 6.ix.44; Yarnton, track to Bladon, abundant, 30.vii.44; Bladon Heath, 13.ix.44. BUCKINGHAMSHIRE: Oakley, field, 2/30.viii.44; Shabbington Wood, 8.vii.44. GLOUCESTERSHIRE WEST: Danby Paddock, 10/14/25.vi.44; Blackpool Bridge, Forest of Dean, 13.vi.44.

Chorthippus brunneus (Thunb.) = *bicolor* (Charp.). SURREY: Kingswood, track and field, 7/9/18.viii.44; Burgh Heath, 12/13.viii.44; Banstead Down, 13.viii.44; Banstead Heath, 16/18.-viii.44; Box Hill, 14.viii.44; Chipstead, 1/3.x.41; Effingham, roadside field, 20.viii.44; Leith Hill, 20.viii.44; White Downs, 20.viii.44; Mickleham Downs, 24.viii.44; Epsom Common, 25.viii.44; Epsom, Oxshott Road, 25.viii.44; Colley Hill, 22.viii.41, 22/24.ix.41, 8/9/-15/17.viii.44. BERKSHIRE: Wytham, roadside, 15/22/28.vii.44, 24.ix.44; Wytham, field, 27.viii.44; White Horse Hill, cross-roads, 3.ix.44; White Horse Hill, moat slopes, 3.ix.44; Appleton, Lower Common, 1.ix.44; Frilford, 3.ix.44; Bow's Hill, 18.ix.41, 5.ix.44; Jarn Mound, 3.viii.44. OXFORDSHIRE: Shirburn Hill, 23.vii.44, 6.ix.44; Waltington Hill, north-west slope, 6.ix.44; Yarnton, track to Bladon, 30.vii.44; Bladon Heath, 13.ix.44; Combe, railway side, 20.ix.44; Merton, 18.vii.44, 4/29/31.viii.44, 1/5/8/14/18.ix.44; Bybridge-Cassington-Hanborough road, 20.ix.44; Eynsham, gravel bank, 1941; Bagley Field, 1941; Hart's Weir Field, 1.ix.44. BUCKINGHAMSHIRE: Shabbington Wood, 8.vii.44. GLOUCESTERSHIRE EAST: Cheltenham-Northleach, roadside, 11.ix.44. GLOUCESTERSHIRE WEST: Danby Paddock, nymph, 10.vi.44; Gloucester to Westbury, roadside (the small part of this road, which is within Gloucestershire East, has no grass verges on which to find grasshoppers. As Clark differentiates between 'roadsides' and 'roadside fields' this record must be referred to Gloucestershire West), 11.ix.44; Blackpool Bridge, nymph, 13.vi.44.

Ch. albomarginatus (Degeer). BERKSHIRE: Wytham, roadside, 15/22/28.vii.44; Appleton Lower Common, 1.ix.44; Frilford, field, 3.ix.44; Bow's Hill, 18.ix.44. OXFORDSHIRE: Bagley, field, 1941; Yarnton, track to Bladon, 30.vii.44; Merton, 29/31.viii.44, 1/8/-14/18.ix.44; Cassington-Hanborough road, 20.ix.44; Hart's Weir Field, 17.ix.41, 1/17.ix.44. BUCKINGHAMSHIRE: Oakley, field, 2/30.viii.44; Oakley, track, 2.viii.44; Shabbington Wood, 8.vii.44.

Ch. parallelus (Zett.). SURREY: Kingswood, track and field, 7/9/18.viii.44; Burgh Heath, 12/13.viii.44; Banstead Down, 13.viii.44; Banstead Heath, 16.viii.44; Box Hill, 14.viii.44; Chipstead, 1/3.x.41; Effingham, roadside field, 16.viii.44; Abinger-Effingham, roadside, 20.viii.44; Broadmoor, 20.viii.44; Leith Hill, 20.viii.44; Epsom Heath, 25.viii.44; Epsom Common, 25.viii.44; Mickleham Downs, 24.viii.44; Colley Hill, 22.viii.41, 22/24.ix.41, 1.x.41, 8/9/15/17.viii.44. BERKSHIRE: Wytham, roadside, 15/22/28.vii.44, 24.ix.44; Wytham, field, 27.viii.44; Wytham, Sidney Patch, 23.ix.44; White Horse Hill, cross-roads, 3.ix.44; White Horse Hill, moat slopes, 3.ix.44; Appleton Lower Common, 31.vii.44, 1.ix.44; Frilford, 3.ix.44; Bow's Hill, 18.ix.41, 5.ix.44; Jarn Mound, 3.viii.44. OXFORDSHIRE: Shirburn Hill, 23.vii.44; Waltington Hill, north-west slope, 6.ix.44; Yarnton, track to Bladon, 30.vii.44; Combe, railway side, 20.ix.44; Bybridge-Cassington-Hanborough,

road, 20.ix.44; Bladon Heath, 13.ix.44; Eynsham, gravel bank, 1941; Bagley, field, 1941; Merton, 14.ix.44; Hart's Weir Field, 17.ix.41, 1/17.ix.44. BUCKINGHAMSHIRE: Oakley, field, 2/30.viii.44; Oakley, track, 2.viii.44; Shabbington Wood, 8.vii.44. GLOUCESTERSHIRE EAST: Cheltenham-Northleach roadside, 11.ix.44. GLOUCESTERSHIRE WEST: Gloucester-Westbury roadside, 11.ix.44. MONMOUTHSHIRE: Trellech, *Narthecium* bog, nymphs, 12.vi.44, and a few adults heard.

Ch. parallelus f. *explicatus* (Selys). During the course of his work Clark found a number of the macropterous form of *Chorthippus parallelus* to which he gave the name '*macroptera*'; this is, however, strictly speaking, a synonym of f. *explicatus* (Selys). Some of these specimens have already been recorded (Clark, 1942), but an examination of the material at my disposal only brought forward the records below. Since there are certain discrepancies between these records and those already published, I have included all those I could find, even although a few will thus be duplicated. It appears that not all Clark's notes are in the possession of the Oxford University Museum. SURREY: Chipstead, 3.ix.41, 1 ♀ 'form *viridis*' [1] (2 ♂♂ 2 ♀♀ specimens examined [2]); Colley Hill, 24.ix.41, 1 ♀ 'form *hyalolateralis*' (11 ♂♂ 23 ♀♀ examined); another section of the notes records, for the same locality and date, without any number of specimens examined, 1 ♀ 'form *rubiginosa*'; Colley Hill, 1.x.41, 1 ♀ 'form *hyalolateralis*' (20 ♂♂ 9 ♀♀ examined). BERKSHIRE: Bow's Hill, 18.ix.41, 2 ♀♀ 'form *viridis*' (116 ♂♂ 92 ♀♀ examined); Appleton Lower Common, 1.x.44, 1 ♀, no colour form mentioned (70 ♂♂ 115 ♀♀ examined). BUCKINGHAMSHIRE: between Oakley and Shabbington, undated but in the 1941 notes, 2 ♀♀ 'form *hyalolateralis*' *and* 2 ♂♂ 'form *viridis*' (64 ♂♂ 50 ♀♀ examined); Oakley, roadside, undated as last, 1 ♀ 'form *viridis*' (47 ♂♂ 47 ♀♀ examined); Oakley, field, 2.viii.44, 1 ♂ 1 ♀ (40 ♂♂ 51 ♀♀ 26 nymphs examined); same locality, 30.viii.44, 1 ♀ (77 ♂♂ 68 ♀♀ examined). The colour forms of the last three specimens were not recorded.

Myrmeleotettix maculatus (Thunb.). SURREY: Burgh Heath, 12.viii.44; Banstead Heath, 16.viii.44; Box Hill, 14.viii.44; Abinger-Effingham, roadside, 20.viii.44; White Downs, 20.viii.44; Colley Hill, 22.viii.41, 8/9.viii.44. BERKSHIRE: Frilford, field, 3.ix.44; Bow's Hill, 19.ix.41, 5.ix.44; Jarn Mound, 3.viii.44. OXFORDSHIRE: Shirburn Hill, 23.vii.44; Bladon Heath, 13.ix.44. GLOUCESTERSHIRE WEST: Danby Paddock, nymph, 10.vi.44; Blackpool Bridge,

[1] Vorontzovskii's (1928) names for the colour varieties are probably best avoided, but they are used here because Clark himself was using them at this time, i.e., in 1941.

[2] These numbers refer to the total number of *parallelus* examined, irrespective of form. The remainder, after deduction of the f. *explicatus* found, would have been the ordinary brachypterous form.

13.vi.44. MONMOUTHSHIRE: Trellech, *Narthecium* bog, nymphs, 12.vi.44.

Gomphocerippus rufus (L.). SURREY: Kingswood, track and field, 7/9.viii.44; Box Hill, 14.viii.44; Chipstead, 1/3.x.41; Effingham, roadside field, 16.viii.44; Abinger-Effingham, roadside, 20.viii.44; Mickleham Downs, 24.viii.44; Colley Hill, 22.viii.41, 22/24.ix.41, 1.x.41, 8/9/15/17.viii.44; Sheepleas, 17.viii.44. GLOUCESTERSHIRE WEST: Gloucester-Westbury roadside, 11.ix.44.

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LITHOMOIA SOLIDAGINIS (HÜBNER) AB. *RANGNOWI* STICHEL IN BRITAIN (LEP: CARADRINIDAE)

On 27th August, 1954, I took at my light trap operated in my garden here a specimen of *Lithomoia solidaginis* Hb., (Golden-Rod Brindle). This may not be remarkable since the species is quite common on Beeley Moors, about seven miles west of the trap.

However it is the first specimen I have ever taken at this spot and moreover it is nearly black. I sent it to Mr. A. L. Goodson for identification, expecting to hear that it had probably come from Germany with the other migrant specimens recorded—but Mr. Goodson informed me that it is not ab. *cinerascens* but ab. *rangnowi* Stichel, and that the B.M. does not possess one like it.

From whatever district it has journeyed I have never before taken one like it in North Derbyshire. I wonder if any collector has met with it in England or Scotland at any time?

J. H. JOHNSON.

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BOOK REVIEWS

A Bibliographical History of the Ray Society, by Richard Curle. London, 1954. pp. vi., 101. Full page plates of Ray and George Johnston, founder of the Society. Cloth. Price, 10s. 6d.

How little we know about the books we read and use! This detailed and scholarly book is packed full of fascinating information about the books published by the Ray Society, their authors and illustrators, the printers, publishers, agents and the sizes of the editions. It even contains a section on 'Works Accepted but not Published.'

An agreeable and intimate note is struck on the first text page by the words 'It is pleasant to record that on two occasions the Society has taken steps to have Ray's tomb at Black Notley in Essex kept in proper condition.'

It comes as a shock to learn that the probable peak of membership (in 1847) was 868 and is now about 450. In 1936 the membership was 246, of which 162 were libraries. Membership reached its nadir in 1941, only 171. All these figures seem ridiculously low for a Society of such eminence and standing in the scientific world, and it is to be hoped that if Mr. Curle's book does nothing else it will raise the membership.

The Ray Society must be accounted fortunate in having Mr. Curle as its historian and bibliographer. Apart from the painstakingly careful work which has so obviously been lavished on the purely bibliographical part of the book, the author has a charm of style which will certainly lead to additional sales of this reasonably priced volume by recommendation.

No one with a library of Natural History books, large or small, should miss this important addition to the knowledge of our history of the literature of the subject.

E.W.C.

The Evolution of an Insect Society, by Derek Wragge Morley, pp. 215, 31 illustrations, London. George Allen and Unwin, 1954. Price, 18s.

The reader must be forgiven if, on reaching page 17 of this book, he decides that this description of an alleged 'commune' of ants somewhere in Surrey is largely invention, that the megalomaniac statistics spring merely from a mind obsessed with huge and improbable numbers. Fortunately, most of the book has little to do with this absurd nonsense, but is a rather dull, padded, occasionally obscure, delivery of the work done on social behaviour of ants by various workers in recent years. This kind of regurgitation is an excellent thing, but unhappily, as one can place so little confidence in Mr. Wragge Morley's entomological integrity, and since he scarcely ever quotes his references, only a well-informed myrmecologist can

say at which points the author is interpreting correctly the words of others.

But let us return to our criticism, which focuses on page 17. Here we are given 'statistics' about the size of the mother nest, e.g., '. . . the base of the dome measures 16 feet across' and 'Here is an edifice . . . which extends in all a height of 9½ feet from its highest thatch to its lowest cellar', having been told on page 13 'the mound of this mother nest stands nearly six feet high. Below ground the nest extends a further three and a half feet at its deepest point.' Yet opposite page 17 is a photograph of the mother colony (complete with Mr. Wragge Morley as yardstick), and it is evident that the nest may be about 2½ feet high, and perhaps five feet across its base. Mr. Wragge Morley continues the effrontery with tales of hundreds of cubic feet capacity, hundreds of thousands of ants, and a mass of unlikelihoods of that sort. Nor does he go to the trouble of telling us how these fantastical figures are computed, how he has established that there are 128 fecund females in his 'commune', and how all these wonderful things have been discovered without digging up the nests. Suffice it to say that the beginning and end of this book consist of passages unworthy of a serious student of entomology.

The middle chapters, having virtually nothing to do with the Surrey 'commune', are more palatable. They trace the origins of ant societies and their development towards the complex patterns of the Formicine genera of to-day. This is done in a pedestrian manner, repetitively, and with some lack of clarity (inevitable, as Mr. Wragge Morley tries to relate constantly points from geological history to his Surrey ants). The most serious general criticism here is that the author makes 'potted' genetics for the benefit of the lay reader, with the invidious result that it all reads like passages out of Lysenko; this is abetted by the journalistic style sometimes used (e.g., page 97, 'The razor of Darwin cut out the unnecessary and retained the essential, and the result was the Michelin grub.')

The concept of the 'excitement centre' ants in relation to nest organization is an important one, but Mr. Wragge Morley endeavours to account for too much by means of this theory, and there are other points that could be mentioned which reveal the writer's preference for the superficial, just as he asserts much with confidence without bringing his evidence to bear.

A. N. BRANGHAM.

Moths, by E. B. Ford. Collins' 'New Naturalist' No. 30. London, 1935. pp. XIX & 266, 24 Black and White plates: 32 coloured plates: 7 text figures: 12 maps. Price 35s.

When in 1946 Messrs. Collins brought out Dr. Ford's 'Butterflies', as the first volume of their 'New Naturalist' series, into a world

starved of good books, they made history in the study of British Natural History, and at the same time set a high standard for future volumes of the same series. The success of that first effort was well deserved both by publisher and author.

Now after a lapse of nine years the same author has written a second volume, *Moths*, which is complementary to the first in that it completes his survey of the British Macro-lepidoptera. The make up of the volume is of the usual high standard that one has come to expect, and it is a pleasure to handle and to read. The price is high, but this continued rise appears to be beyond the control of publishers of good books to-day. The coloured plates are attractive, but here and there the colours are not quite true to nature.

Everyone who writes a real book impresses his own personality on it, and is justified in emphasizing his own special interests. Dr. Ford is an outstanding student of Genetics, and his book reflects both the value of insects to the Geneticist, and the importance of the study of inheritance in the study of Entomology. The chapters are as follows:—Structure and Physiology: Genetics: Genetics of Sex: Genetic Interaction: Polymorphism; Dispersal: Protective Devices: Injurious Moths: Geographical Distribution: Types of Habitat: Relict Faunas: Geographical Races: Melanism, and Evolution. Thus out of fourteen chapters six are primarily genetical in outlook, and another five deal with problems of dispersal and distribution, in which the importance of inheritance and genes is often (and possibly rightly) emphasized.

As one who was brought up under the influence of William Bateson I can share to a certain extent Ford's enthusiasm. I agree that the amateur collector of moths should try to understand better the significance of variation. If he would breed on some ordered plan from his rare varieties, not only would the study of Entomology benefit, but he himself would find a new interest and a new enthusiasm in his work. Collections are very necessary, but only as means to an end; and a slightly worn specimen that has been the starting point of a breeding experiment, is a possession more worthy to be proud of than a perfect specimen killed at sight.

My only fear is that Ford's brilliant exposition of the subject may result in all our young Entomologists becoming Geneticists, and so perhaps neglecting other aspects of insect life.

In the first chapter—devoted to a necessarily condensed account of structure and physiology—the production and perception of scent is well dealt with, but in the case of sound only hearing, and not sound production is mentioned. As a result one gets the impression that the hearing organ is for the purpose of perceiving sounds extraneous to the species. Is this so?—I do not myself know! The sound production of the Death's Head moth is usually said to be for the purpose of frightening enemies. Has it any value within the species? Once again I do not know.

In the same chapter is a discussion of the sight of moths, and arising out of this some notes on the use of light traps and of ultra-violet light. I am not entirely in agreement with the Robinson's theory of dazzle in insects approaching a bright light, which is quoted here. Some experiments that we have carried out at Rothamsted indicate that the efficiency of the Robinson's trap is partly at least dependent on the momentum of the insects in light; and the traps give a better catch of the larger heavy-bodied insects than of those of smaller size.

In this section there is one statement which is entirely contrary to my own experience. Ford states on p. 17 that the use of light traps has shown that 'males fly higher than females, so that a larger proportion of these are caught on raised positions and at upper windows'. During two and a half months in 1933 we caught moths in two identical light traps at Rothamsted, one about three feet from the ground and the other on the corner of a flat roof at about 32 feet. Out of 930 moths caught in the former 15 per cent were females, while out of 1775 moths in the high trap 26 per cent were females. A repetition for one month in 1934 gave 9 per cent females out of 310 moths in the lower and 27 per cent out of 401 in the upper trap. In 1935 and 1936 we repeated the experiment, but in these years the upper trap was suspended from a large tripod and hung 30 feet in the air immediately above the lower trap. The catches in this case were less in the upper trap than the lower, but the proportions were 14 per cent females out of 5,450 moths in the lower and 23 per cent out of 722 in the upper in 1935; and 6 per cent out of 272 compared with 20 per cent out of 184 in 1936. All these results indicate a *higher* proportion of females at 30 feet than nearer the ground.

The chapter on protective devices is particularly interesting, but I think that more emphasis could have been laid on the necessary combination in cryptic forms on the one hand of colour, pattern and shape, and on the other hand the ability of the insect to choose a site and take up an attitude which makes the best possible use of its cryptic form. The illustrations for this chapter are disappointing, as none of them show an insect which is really difficult to see. There is still a wide field open to the amateur naturalist to take photographs (preferably in colour) of insects showing cryptic resemblance to their surroundings—but they should always be taken in the field when the insect has chosen a particular site and attitude from all the others available in its environment. However, it must be remembered that, even at the best, such pictures will only show the failures. The really good examples of concealment will be those that the photographer has not seen.

In the same chapter in a discussion on mimicry Ford writes 'a mimic must be much less common than its model; but it can, and generally does, escape from the impasse and increase its total popu-

lation by evolving polymorphic forms, some or all of which copy different species'. I find this statement rather putting the cart before the horse. If polymorphism arises, then the mimic might be able to increase in number to a higher limit, but I see no reason to believe that polymorphism is more likely to evolve because such an impasse exists. The explanation appears teleological—but perhaps I have misunderstood.

Later Ford writes 'Populations of Lepidoptera overcome the ravages both of parasites and of disease by the most fundamental of protective devices: that is to say an adjustment between the number of eggs laid and the amount of elimination throughout life, so as to secure that each pair of insects shall on the average reproduce one pair and no more'. Once again I think that the cart is before the horse—perhaps if I said the engine was in the boot instead of the bonnet it would be a more modern simile. I would put the problem as follows:—An insect is capable, from its genetic make up, of laying a certain number of eggs under certain environmental condition. The number of those surviving will depend on many varying factors outside the genetic make up of the species, such as the physical environment—food supply—parasite predators and disease—competition and co-operation with other species, etc. If the number surviving from the eggs of each original pair is more than two, the species will increase in numbers in that generation; if less than two survive the population will be decreasing. Although at any moment we recognise a certain level of abundance for a species in a particular area, the so-called balance is a very unstable affair, particularly in animals with high birth rates, high death rates and a short life cycle. If the species increases very rapidly, then in most cases the hazards of survival will become greater and the increase in number may be brought to a standstill or reversed. But, even within the short space of time for which accurate records of insect numbers are available, populations have been known to change a thousand-fold or more, and it is difficult to say that any level is more normal than any other. The hazards of life are partly at least dependent on the number of eggs laid, but I cannot believe in any new genetic adjustment arising *because of* increased hazards.

There are, here and there, a few misprints and errors, and I might point out that the moth illustrated on plate 17 as the 'Silky Wainscot *C. maritima*' is almost certainly *M. flammea*.

These digressions and criticisms suggested by reading Ford's book are not to be taken as an implication that I do not consider the book good—rather the reverse. Every good book stimulates thought and discussion, and without disagreement of interpretation there would be no progress. I have no hesitation in saying that all naturalists would be better off for possessing a copy to read—to dip into—to agree with—to disagree with; but always to be glad it was written.

C. B. WILLIAMS.

Monographie systématique, phylogénétique et zoogéographique des Hyménoptères Crabroniens, by Prof. J. Leclercq. Liège, 1954. pp. 372. 84 maps. 40 text figs. Paper covers. Price in the British Commonwealth £5.

This monograph is an attempt to bring together all that is known about the Sphecidae subfamily *Crabroninae.* Apart from information which is taxonomic in the narrowest sense, very little is known about the group outside Europe, so that most of the facts of a more general nature concern species of interest to British entomologists. The primary aim of the author has been to construct a phylogenetic classification of the species and to work into this, partly testing it by so doing, information from a number of other fields, such as general physiology, coloration, distribution, ethology. There is a key to the genera and subgenera of the subfamily and a list of the world species and an extensive bibliography.

The backbone of the work is the suggested phylogeny of the Crabroninae based on the study of their external morphology. In one respect the author is working on relatively safe ground, for the palaearctic Crabroninae were the subject of a wonderful monograph by Kohl and the generic classification of the species from other regions had been fairly completely worked out by Pate. It was possible therefore to construct a phylogeny on the basis of characters already described in the literature. When, however, one considers the derivation of the group, which will largely determine what is regarded as the primitive Crabronine, the position is rather different. There is no convincing scheme of the relationships among the subfamilies of the Sphecidae nor of the aculeates in general; in fact very little speculation on this subject has been published. To construct even moderately reliable phylogenies more information is required than suffices for an efficient classification. For this reason I believe it would have paid the author to have investigated the structure of the Crabroninae further and to have arrived at more convincing views on the relationships amongst the aculeates. In particular, the labrum, the mouthparts, and the male genitalia would repay examination. Moreover, the parts of the Hymenopterous thorax need much more study if they are to be used in phylogenetic speculation; it is not at all certain that some of the proposed homologies are correct. The derivation of the Sphecidae from the Pompilidae seems to me most unlikely, though I would not like to say without much more profound study that Dr. Leclercq is certainly wrong; at least he should consider the significance of the primitive Pompilid pronotum, which ends ventrally in a free rounded lobe. However, apart from the question of a Pompilid ancestry for the Sphecids, his views on their relationships seem to be very reasonable as far as one can judge from the rather limited information available.

The attempt to test phylogenetic theory based on structure by independent evidence from colour, size of adult, habits, nature of

prey, etc., is perhaps praiseworthy in intention, but seems in some examples rather fantastic in practice. So many of these features of the living organism seem likely to be modified rapidly by the adaptive needs of the species that they could not be expected to show much agreement with the slower process of evolutionary adjustment of structure. In particular, the suggestion that primitive Crabronines catch the sort of insects which were available in the early tertiary when they were first evolved, whereas more specialized, later evolved Crabronines take later evolved prey, seems to need substantiating by a great deal more evidence, and to be so highly speculative that it would be better left unpublished.

The discussion of the geographical distribution of the group seems to me to be valuable and gives a well-balanced account of the views of many of the leading authorities. The author does not find it necessary to assume any major shift of the continents to account for the facts. There is an interesting discussion of the fauna of Great Britain and Ireland. The species are almost all ones with unspecialized needs and wide distribution outside our islands. A useful feature of the work is a collection of all the records of nesting habits and prey, which seem to be very complete. The work is well produced and seems to be free from misprints. Speaking for myself and perhaps for some other simple minded Hymenopterists, I would have been prepared to sacrifice a good deal of speculative matter if that had allowed the inclusion of a key to the species. O. W. RICHARDS.

Fáunula Lepidopterológica Almeriense, by Ramon Agenjo. Madrid, 1952. pp. 370. 24 plates (5 coloured). 35 figs. Paper covers. Price In G.B. about 45s.

This study of the Lepidoptera of one of the South-Eastern provinces of Spain does not pretend to be complete—indeed, the author states that it is simply a first contribution to the lepidoptera of the region and the results of his study of material collected in the years 1942 and 1948. No doubt specialists on various of the groups included in this study could find things to criticise—nevertheless it is praiseworthy that such an attempt should have been made. To say merely that this work will lay a foundation on which others may build is, however, not enough. Agenjo performed an immense amount of work in the preparation of this book (over 1,000 preparations of genitalia were made) and astoundingly large proportion of material was found to be new to science, new to Europe, or new to the Iberian peninsula.

One new subfamily and seven new genera are described as well as seven new species.

The Spanish lepidoptera are but poorly known, and it is to be hoped that this work will be followed by others on different districts; many problems connected with the lepidopterous faunas of the S.W. of England and the W. of Ireland can probably only be elucidated when the fauna of Spain is better known. E. W. CLASSEY.